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Assemblages of Patient Safety: Bringing together matters of concern between design and multiple knowledge practices in healthcare

Balatsas-Lekkas, Angelos

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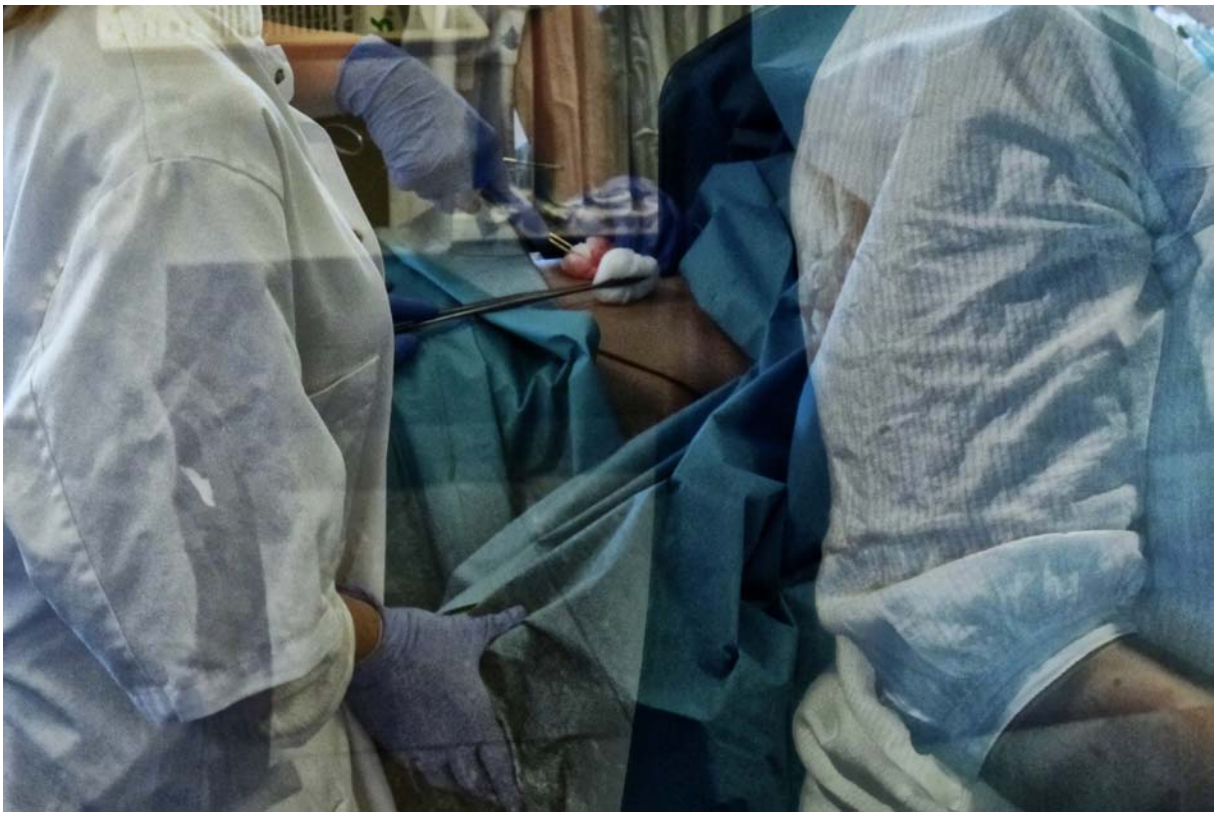

PhD Thesis

Angelos Balatsas-Lekkas, September 2016

Technical University of Denmark
Department of Management Engineering

Angelos Balatsas-Lekkas

Assemblages of Patient Safety: Bringing together matters of concern between design and multiple knowledge practices in healthcare.

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DTU Management
Department of Management Engineering
Division of Technology and Innovation Management

Technical University of Denmark

Diplomvej
Building: 372, 231
Denmark
E-mail: able@dtu.dk
Phone: (+45) 45254545

Summary
This thesis identifies how design processes emerge during the use of devices in healthcare, by attending to assemblages where contingencies of risk and harm co-exist with the contribution of healthcare professionals to the safe care of patients. With support from the field of Science and Technology Studies, the thesis approaches such assemblages as heterogeneous in nature comprising of human and non-human entities that share capacities for action. The multi-sited ethnography of specific healthcare settings formed the basis of an analysis of how the non-human, as an actor, enters into emergent practices of interdisciplinary care. Three empirically informed cases are presented:

1. A case of healthcare simulation concerns the examination of critical event scenarios and offered insights into the involvement of clinicians in the development of such scenarios.

2. A case of a mother-child healthcare facility re-location concerns the examination of young patient hygiene and offered insights into the involvement of non-clinicians in the interdisciplinary development of hygiene systems.

3. A case concerning the establishment of a new organizational department within a hospital allowed a brief examination of the framing of patient safety at the early stages of design. This provided insights into the collaboration between clinicians and designers.

The above cases serve as an empirical backdrop for the thesis' argument that heterogeneous patient safety assemblages are shaped through: a) various modes of collaborative work and b) orderings and temporary spaces comprising of trade-offs and transformations for healthcare professionals, artifacts and locations that partake in patient safety work. The analysis reveals that patient safety assemblages unfold continuously and encompass multiple practices whose scope and boundaries are contested and socio-materially reconfigured rather than being defined from the outset.

By accounting for potential implications which the above-mentioned reconfigurations entail, the thesis proposes non-human agency, materiality and temporary spaces as elements of a generative framework. In contrast with approaches that focus only on the means for designing new devices, the proposed framework allows the generation of insights concerning the reconfigurations that devices-in-use bring in healthcare settings and how healthcare professionals participate in such reconfigurations during their daily work. The thesis contributes to an understanding of the constitution of knowledge practices in collaborative design by foregrounding some of the ways that patient safety practices and care delivery become design-relevant. Such bridging provides a point of departure for attending to the formation of boundaries at the early stages of design and to the role of designers in those stages.

No matter how many prisons they build, and even if the(ir) grasp tightens,
our mind is a vagabond, eternally escaping.

Thanasis Papakonstantinou

To Marjo, Leonidas, Iiris, Lambros and Danae

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Foreword

During my studies and work in Greece (BSc on Industrial Design Engineering) and my masters studies in Denmark (MSc in Engineering Management) I became interested in exploring the role that collaborative work plays for the design of products and services that relate to care delivery.
Of course, such exploration could have been done in many ways. However, particular masters courses, such as that of "sociotechnical design" (without hyphen!), led me to approach collaboration in design with support from the field of Science and Technology Studies (STS) and more particularly through Social Construction of Technology and Actor Network Theory. An overall thinking that accompanied those courses was that boundaries between the development and use of artifacts are not clear-cut and that the former continues to unfold throughout various use contexts.
While undertaking student projects for such courses I became further intrigued by the potentials that ethnographic methods such as interviews and observations had for studying collaboration in design. Instead of drawing only on my own (limited) experiences and on the World Wide Web, ethnography provided to me a chance to connect with people and things of my daily life in new and exciting ways.

Table of contents

1. Introduction

1.1 In search of collaborative design in healthcare and general overview

Collaborative design is often understood as a subject that concerns designers and other engineers who are involved in the development processes of new products and services. In this project I attempted to approach collaborative design as a process that potentially takes place in settings where artifacts and services are appropriated by a variety of professionals who work toward the cure of patients. The focus on healthcare was supported by my curiosity to figure out whether the collaboration that is required for curing patients could allow me to better understand how collaborative design processes span across contexts of design and use practices. The choice of healthcare was further motivated by the design-oriented vocabulary (e.g. design of services) that is currently being employed in different parts of healthcare systems. Having Science and Technology Studies (STS) as a theoretical backdrop, the foundations of this PhD project entail:

- A theoretical interest in understanding how, and with what consequences, collaboration emerges as a form of work throughout the development of artifacts and services in healthcare.
- An ethnographic approach to design, design practices and collaboration.
- The aim to provide empirically informed insights to design professionals and healthcare professionals who have an interest in collaborative design processes that take place in healthcare.

The empirical scope that I draw on for studying collaboration in design concerns a particular set of heterogeneous practices that take place in organizations that belong to the Danish healthcare system (e.g. facilities in hospitals, see also Section 1.6). A common point in these practices can be found in the daily work that takes place in healthcare settings, where contingencies of risk and harm co-exist with the contribution of healthcare professionals in the safe care of patients. Throughout the thesis, I lay out the idea that the study of practices in which patient safety appears as an inherent concern may offer insights into the emergence of collaborative design processes in healthcare. The analysis of such practices is mainly supported by an Actor Network Theory (ANT)-informed approach to the analytical notion of assemblage.
The rest of the introduction is structured as follows: Section 1.2 briefly describes the thesis' positioning in literature, which is concerned with relations between design and patient safety. Section 1.3 sketches the thesis' approach to patient safety practices. Section 1.4 refers to the main analytical notions which constitute the theoretical framework of this thesis. In Section 1.5, the main and sub research questions are presented. Section 1.6 provides a short introduction to the case organizations and a brief overview of the Danish healthcare system. Section 1.7 provides the structure of the rest of the thesis as well as a brief overview of the articles that accompany it (and can be found as appendices 1 and 2).

1.2 Design for patient safety: What does the preposition "for" mean?

Various academic strands investigate relations between design and patient safety. The relations that have already been drawn by previous literature became visible through a literature review that took place during the early stages of the PhD project. Following the Institute of Medicine's

(IOM 2000) call for patient safety improvement, the field of Human Factors has already provided some relevant literature.[1] A few publications include: 1) a special issue in BMJ Quality and Safety journal about *Quality and Safety by Design* in 2006, 2) a publicly funded article-based report published by The Center for Health Design (2012) in the United States, *Designing for Patient Safety: Developing Methods to Integrate Patient Safety Concerns in the Design Process* and 3) a series of reports on Design for Patient Safety that were published by the British Department of Health and Design Council– with the most relevant being entitled: *A system-wide design-led approach to tackling patient safety in the NHS* (2003).

Human Factors-oriented publications, such as the aforementioned, focus only on particular relations between design and patient safety; therefore they exclude others. Schematically their focus is on the methods and models that design practitioners and Human Factors researchers draw on for engaging healthcare professionals in the development of safer devices and services. For example, a group of engineering design and Human Factors researchers (Clarkson et al. 2004) have reported on how they used workshops and focus groups as methods to engage healthcare professionals in a broader *design-led approach to preventing medical errors* (p.126). Another approach that belongs to the Human Factors literature concerns the development of models for patient safety improvement. An example of such models is Carayon's et al. (2006) Systems Engineering Initiative for Patient Safety (SEIPS). Carayon and collaborators have argued that the application of their model can support healthcare professionals' interventions towards patient safety improvement by allowing them to consider various, yet distinct *technological, organizational, job environmental and personnel factors* (p. i56).

An implicit assumption in the above-mentioned approaches is that patient safety and design practices: 1) are separate, 2) they reflect particular professions, and 3) can be brought together through an explicit and well-delineated context for collaborative work *between designers and healthcare professionals*. What these approaches *do not* take into consideration are the *consequences of designing for patient safety* and the practical implications that arise when the devices, models and other artifacts are appropriated in daily work.

This thesis approaches design and patient safety in a different way. It mainly draws on the idea that design is a sociotechnical process which continues during the use of devices, models and services. It takes as a premise the collaboration *between* healthcare professionals and focuses on the ways that they appropriate the technology (e.g. artifacts and devices) that is already part of their daily work environment (Suchman 2002). Such appropriation may entail actions of modification, adjustment and reparation. In this way, this thesis aims to explicate the potential contribution of safety work and practices for understanding the premises under which collaborative design processes already take place in healthcare. Central to this aim is the empirical study of patient safety practices.

1.3 Approaching patient safety practices

The ethnographic research of patient safety practices has concerned various STS-informed researchers (e.g. Waring 2009, Zuiderent-Jerak 2015, Jerak-Zuiderent 2012, Jensen 2008). These have inspired this project to examine the daily work of healthcare professionals with the use of ethnographic means. An additional source of inspiration came from a smaller niche of literature.

[1] A common point of departure among the Human Factors-oriented approaches to patient safety and design is the "Swiss cheese" model and its applications to healthcare (e.g. Reason 2000, 2004).

Briefly put, such literature approaches actions toward the prevention of risk and errors *during* care delivery processes as a form of *innovation from within* (e.g. Mesman 2011, Iedema et al. 2013). The central argument of such approach is that actions of error prevention (and other forms of safety work) are inherent to the daily work and routine of clinicians. An understanding of those requires the explication of clinicians' strengths *and not only* the identification of factors that have led to errorism. Such literature has finally shaped the thesis' ethnographic approach towards patient safety practices in the Danish healthcare system (see this Chapter, Section 1.6).
However, this thesis' analytical approach to patient safety practices is different because: 1) it does not depart from the social interactions between human actors but from the agential role that artifacts may play in the work of healthcare professionals and other actors and, 2) it does not only aim to explicate the strengths of clinicians but also those of other healthcare professionals with a non-clinical background (e.g. ward-cleaners). Therefore, the thesis attends to *what works well* only as a backdrop for foregrounding the intricacies between the development and use of artifacts that support the collaboration of healthcare professionals.[2]
Thus, central to the thesis' analytical approach to patient safety practices is the relation that healthcare professionals develop with the artifacts that they use in their daily work. Such artifacts partake in the work practices of healthcare professionals, affect their efforts to be efficient (e.g. Berg and Timmermans 2000) and constitute *assemblages* where safety emerges throughout interdisciplinary work (Barry et al. 2008).
The thesis approaches artifacts that belong to healthcare settings, as entities which circulate within various contexts of use. For examining how such circulation takes place, the thesis draws support from the analytical vocabularies that support the notions of boundary objects (Star and Griesemer 1989), epistemic objects (Knorr Cetina 2001, Ewenstein and Whyte 2009), intermediary objects (Boujut and Blanco 2003) and conscription devices (Henderson 1999). For addressing the relations between the development and use of artifacts the thesis draws inspiration from the "Scandinavian tradition" of research on computer systems (e.g. Greenbaum and Kyng 1991, Bjerknes et al., 1991, Clement 1993, Aanestad 2003). The works of these authors have collectively shown how and when boundaries between design and use contexts become more or less clear-cut across time. It has also pointed to the implications that arise for those partaking in the shaping of such boundaries.

1.4 Assemblages

The thesis uses the notion of assemblages for analyzing patient safety practices and for recounting the potential agential role of artifacts and other non-humans in the formation of such practices. Drawing on the treatment of assemblages by Deleuze and Guattari (1987) and Marcus and Saka (2006), the thesis attends to: 1) the processes through which humans and non-humans form assemblages, 2) the coherence and interdependence of heterogeneous entities that comprise assemblages and, 3) the processes under which heterogeneous entities gain or lose their capacity to act. The notion of reconfigurations (see Chapter 2, Section 2.2) and the aforementioned object-oriented notions (see Chapter 2, Section 2.3) have allowed the explication of mutual trade-offs and transformations between people, be they clinicians or others (e.g. ward-cleaners), artifacts and locations that partake in the constitution of patient safety assemblages.

[2] A more elaborate discussion about this and similar literature is made in Chapter 3, Section 3.2.

1.5 Research questions

The aim of this thesis is to inform various practitioners about the constitution of collaborative design processes in healthcare. These practitioners might be design professionals with a focus on healthcare and an interest in use practices after design (e.g. user-centered design) but might also be healthcare professionals (be they clinicians or non-clinicians) that have an interest in approaching their own and their colleagues' work as design practices.

Main Question

- **How may the constitution of patient safety practices and their heterogeneous boundaries offer insights into the emergence of collaborative design processes in healthcare?**

Sub-questions

1. **In what kinds of heterogeneous assemblages does patient safety become an inherent concern in the work of healthcare professionals?**

2. **How and what elements are shared between collaborative work towards care delivery and collaborative design processes?**

1.6 Case organizations[3] and brief overview of the Danish healthcare system

This Section presents the case organizations where fieldwork was conducted from mid 2014 until mid 2015 and it provides a brief overview of the Danish healthcare system. What is common among all case organizations is that they entail explicit relations to design. However, these were approached as occasions for doing empirical research about patient safety practices.

SIM

SIM is a healthcare simulation center, it was founded in 1997 and it is situated at the last floor of a university hospital that belongs to the Capital Region of Denmark. It employs thirty permanent members of staff, including clinicians and other professionals (e.g. psychologists) who are involved in the Danish healthcare education. Some of them also do research on patient safety and simulation. Most of SIM's employees are working as *instructors* of healthcare simulations with the broad aim to improve patient safety by facilitating *role-plays*. According to SIM, role-plays are a method which allows clinicians under simulation training to *practice some clinical situations before they become serious*.

The transformation of *critical events* into scenarios for healthcare simulation allowed for the study of scenario development as a patient safety assemblage. A central finding was that simulation scenarios of critical events were continuously modified and adjusted throughout their performance by participants and instructors. The analysis of such modifications foregrounded the

[3] Throughout the thesis, the mentioning of the case organizations' real names, except that of "innovation units", has been avoided. Instead, pseudonyms are used. The use of pseudonyms also counts for 1) *all* the quotes that belong to the informants of the thesis and 2) all the names that are used in the vignettes that appear in the main body of the thesis and in the articles found in appendices 1 and 2.

role that a particular group of clinicians, the instructors, played in the constitution and displacement of a particular patient safety assemblage that spans across care delivery and simulation practices.

Mother-child healthcare facility

The mother-child healthcare facility (hereafter facility) is based within the premises of another university hospital that also belongs to the Capital Region of Denmark. The facility focuses on the treatment of mothers and children and is organized in ten wards: anesthetics and surgery, children's surgery, pediatrics and adolescent, fertility, gynecology, growth and reproduction, clinical genetics, neonatal, obstetrics, and, psychology, education and social advice. It currently hosts one thousand and five hundred permanent staff members (two hundred of them are paid by external funds).During the time of fieldwork, an exploratory study was taking place within the hospital. The study was part of the early stages of a relocation process according to which the mother-child facility would be relocated to a new and physically separate location from the university hospital. The study would indicate the principles upon which the new facility would be designed and constructed. Even though the fieldwork at the existing facility did not aim to explicitly contribute to the design of the new facility, it focused on a particular challenge that emerged throughout the exploratory study. Briefly put, the facility's management expressed concerns about *the securing of children's hygiene around toys, playrooms, in wards and beds.* This seemingly technical case offered a chance for examining the constitution of patient safety assemblage*s* that enabled young patients to *play* and/or to be *taught* without risking the acquisition of hygiene-related infections.

Innovation Units (IUs)

The so-called Innovation Units (IUs) are small organizational departments within existing healthcare settings (e.g. hospital campuses). IUs operate under the explicit aim of developing and commercializing artifacts and services that solve particular issues of quality and safety in the Danish healthcare system. IU staff members are professionals with a broad orientation in design (ranging from industrial and service designers to information technologists). Two IUs were studied that belong to the North Denmark region and to the Southern Region of Denmark. This case analysis approaches the constitution of patient safety assemblages by addressing how the cooperation of clinicians with professionals with bearings on design practices (e.g. industrial designers) has taken place during the development of medical devices and care delivery services. Methods that were in use at IUs, such as user-centered workshops and prototyping, were taken as points of departure for the analysis of patient safety assemblages.

Overview of the Danish healthcare system

The Danish public healthcare system is financed through income taxations and medical treatment in Denmark is available to all Danish residents and EU citizens free of charge. Its structure follows Denmark's division in five state-owned regions (Capital Region, Central Region, North Denmark Region, Zealand Region and Southern Denmark region) and ninety-eight municipalities. Briefly put, the Ministry of Health administers the functions that are related to the organization of hospitals through local agreements with each of the five regions. The regions are responsible for the provision of care in hospitals, psychiatric services and each region has its own

general practitioners and specialists. Each region's municipalities are responsible for home nursing, public health, dental treatment for children and disabled people, social psychiatry, rehabilitation and child-preventive care (See below the diagram of Olejaz et al. (2012).

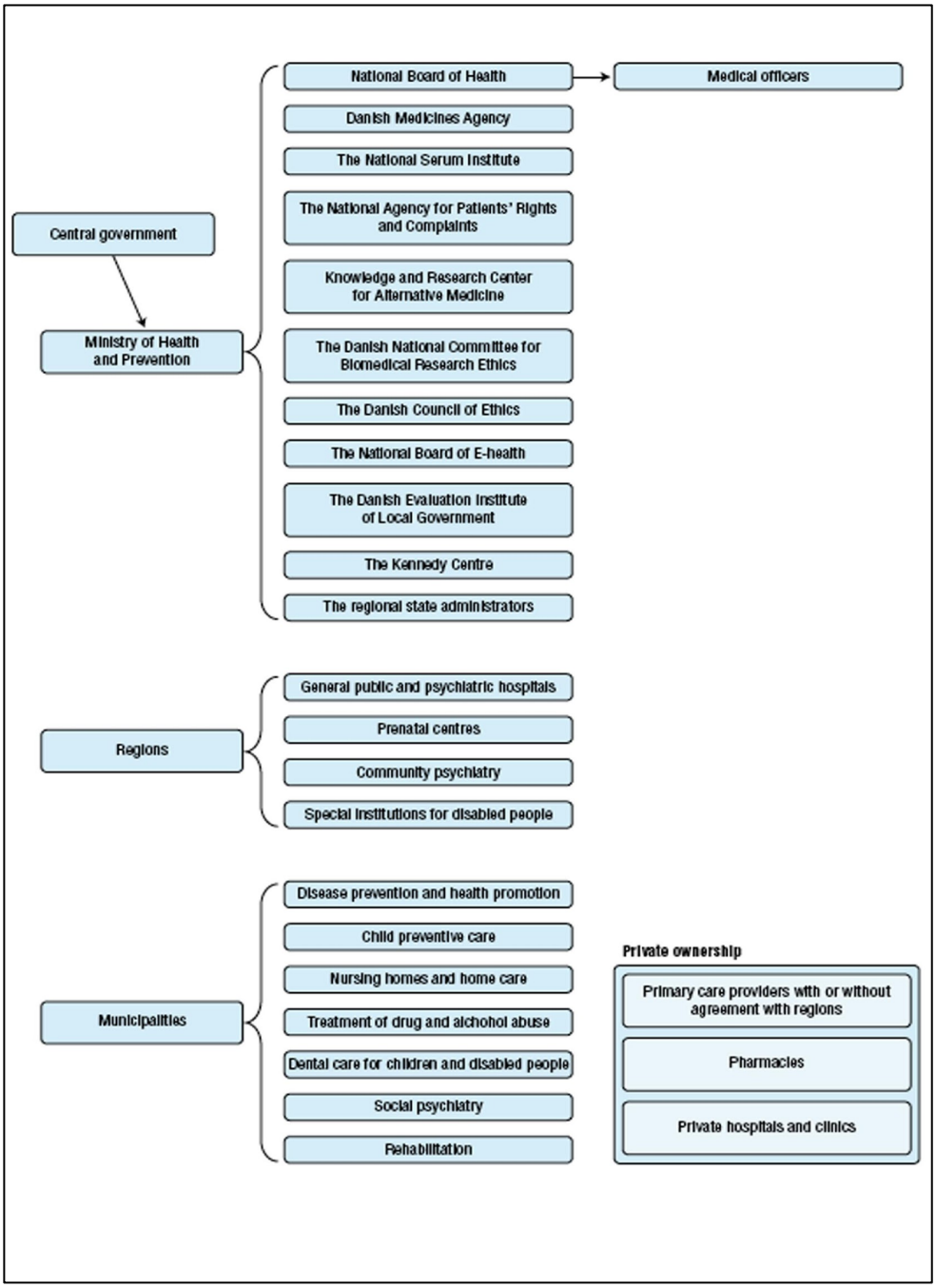

Table 1. Diagram containing an overview of the Danish healthcare system. The diagram is taken from a publicly available report that was published by the World Health Organization in 2012 and was authored by the University of Copenhagen, Department of Public Health and the European Observatory of Health systems (referenced as Olejaz et al. 2012).

The healthcare simulation center (SIM) and the mother-child healthcare facility belonged to the Capital Region of Denmark and were situated in Copenhagen's municipality. Each of the visited Innovation Units which belonged to the North and to the Southern regions of Denmark were situated at the premises of each region's university hospital.

1.7 Structure of the Thesis

Two articles intended for publication in academic journals *support* this thesis. The first (appendix 1) is single authored and has been submitted for the special issue of "infrastructuring and collaborative design" in the Journal of Computer Supported Cooperative Work (JCSCW). The second (appendix 2) is co-authored with associate professor Jessica Mesman (Maastricht University) and will be submitted to the journal of Quality and Safety in Health Care (BMJ Quality and Safety).

Each of those articles has offered various contributions to the thesis. These become more concrete and visible for the thesis' readership in Chapter 4 (see also below). However, it is worth mentioning that the single authored article provided the empirical basis for analyzing the aforementioned scenario development at the healthcare simulation center "SIM" and the co-authored article provided the empirical *as well as* the analytical basis for examining young patient hygiene at the mother-child healthcare facility.

Before proceeding to the structure of the thesis a brief overview of each article is offered.

Articles

The first article is entitled *Infrastructuring in healthcare simulation: A case of collaborative design 'in the wild'* (Balatsas-Lekkas, submitted) and approaches the development and use of scenarios for healthcare simulations at SIM as a case of collaborative design. With support from the notion of *infrastructuring practices*, the article analyzes the participation of healthcare simulation instructors in the development and use of scenarios. Central to the analysis are the interactions of instructors with a particular artifact, the *script-form*. These are examined by drawing on data that concern an explicit process of scenario design (in the form of workshop) and the facilitation of various scenario-supported role-plays. The article's argument is that: 1) the instructors participate in the development of scenarios along with other heterogeneous entities, 2) the shaping of scenarios is a temporary, as well as, a continuous process and, 3) scenario development enables the emergence of multiple forms of participatory work practices.

The second article, *Toys and teachers in children's hygiene: examining non-clinicians' contribution to patient safety practices* (Balatsas-Lekkas and Mesman, drafted) explores the potential contribution of daily non-clinical work to safety practices. The article argues that the delivery of safe care relies *also* on non-clinicians and that their involvement in different aspects of a patient's pathway (including his/her welfare/wellbeing) is not fully acknowledged in research about patient safety practices. To support such argument the article provides: 1) a critique that has the form of literature review. The review regards the inclusion of non-clinicians in patient safety initiatives and in research designs that focus on patient safety practices and 2) a case that is based on empirical material generated at the mother-child facility. The case regards the involvement of teachers and pedagogues in young patient hygiene. Drawing on the notion of *ordering,* the analysis attends to the use of toys in *playrooms* and the development of "clean

enough" copies of educational material. Items 1 and 2 lead the article to discuss some consequences that the methodological and analytical inclusion of non-clinicians generate for what counts as safety and safety practices.

Thesis' Chapters

Chapter 2 lays out the theoretical framework of the thesis. This is explicated in three Sections. Section 2.1 concerns the thesis' overarching notion of assemblages. Section 2.2 describes the notion of reconfiguration and brings into purview concerns about the constitution, transformation and displacement of assemblages. Section 2.3 deals with the notions of boundary objects, intermediary objects, epistemic objects and conscription devices. The notions that are discussed in Sections 2.2 and 2.3 constitute the vocabulary that supports the analysis of patient safety assemblages.

Chapter 3 lays out the thesis' methodological grounding. Section 3.1 addresses the methodological principle of *rolling the snowball* and explicates some of the challenges encountered when accessing the empirical field, while engaging multiple sites for data generation and making site-specific delimiting choices. It rounds off by discussing the crafting of audiences throughout the PhD project and the latter's potential contributions. Section 3.2 addresses the methodological principle of *following the actors* as a provocation *for explicating the literature* that has enabled the empirical examination of patient safety practices. Firstly, it accounts for the inclusion of human actors and discusses the implications for approaching them through categories, such as "users of artifacts." Secondly, it accounts for the empirical inclusion of artifacts and other non-humans and brings into focus a set of metaphors that have accompanied the empirical examination of the aforementioned case organizations (Section 1.6, this Chapter). These are the metaphors of laboratory work, dirt and projects. Thirdly, it uses the ideas of controversies and conflicts as occasions for discussing the project's positioning among "positive" empirical approaches to patient safety practices. Section 3.3 deals with the methods for data generation and analysis. These are presented in the following order: participant observations, interviews, workshops with participatory engagement and case analyses with the support of vignettes and photographs.

Chapter 4 is the main analytical chapter of the thesis and provides three case analyses and a summary. Each case analysis has its empirical basis on one of the aforementioned case organizations and is supported by the theoretical framework that was presented in Chapter 2. Moreover, each case analysis presents the workings of heterogeneous assemblages where patient safety has already been an inherent, yet explicit aspect of the daily work of healthcare professionals in healthcare settings (see above sub-question 1).

Case analysis 1 draws on empirical material that concern the healthcare simulation center SIM. By using the first article (appendix 1) as its empirical backdrop, the case analyzes how *critical events* that take place in care delivery settings become elements in scenarios that support the performance of a particular kind of healthcare simulation, the role-plays.

Case analysis 2 draws on empirical material that concerns the mother-child facility. By using parts of the second article (appendix 2) as its empirical and analytical backdrop, the case

analyzes how young patients are able to *play* and to be *taught* without risking the acquisition of hygiene-related infections.
Case analysis 3 draws on empirical material that concerns Innovation Units (IUs). The case draws on interviews and other empirical material that concern the establishment of an IU within the premises of the hospital. It analyzes how the IU allowed clinicians and design-oriented professionals (e.g. service designers) to develop devices and services for safer care delivery.
The chapter concludes with a brief summary of the three case analyses. The summary takes a brief stock on the collaborative modes of work of healthcare professionals and it sets the stage for the discussion that follows in the next chapter.

Chapter 5 puts the analysis of Chapter 4 into perspective by discussing the relation that patient safety practices have with emerging collaborative design processes in healthcare. Firstly, it provides an overview of the ways that the aforementioned object-oriented notions have supported the approach of the thesis to non-human agency. Secondly it presents three elements of a generative framework. These could sensitize practitioners with an interest in design about the ways that collaborative design processes can be identified within contexts of use. Thirdly, it accounts for the project's methodological approach to safety practices and to the issue of designing for patient safety. The chapter rounds off by briefly outlining potential academic areas that may support the explication of emerging collaborative design processes in healthcare and the scope of an object-oriented analytical framework.

2. Theory

Introduction and Structure

This chapter outlines the thesis's main analytical approach. In doing so it reviews and describes the main notions that have informed the case analyses that follow in Chapter 4 and some of those included in the articles (Appendices 1 and 2). More particularly, the chapter deals with the notions of assemblages, and reconfiguration, as well as with the following notions that share a focus on the role of objects in collaboration[4] between professionals: boundary objects, intermediary objects, epistemic objects and conscription devices. All these notions are informed by the Science and Technology Studies (STS) research field. However, their conceptual development has also concerned other STS-informed fields such as that of Computer Supported Cooperative Work (CSCW).

The chapter discusses all the aforementioned notions in light of particular concerns that relate more closely to Actor-Network Theory (ANT). It treats each notion considering ANT's principle of *generalized symmetry* (Callon 1986) according to which non-humans and humans share a capacity to act. Drawing on the same principle this thesis approaches patient safety practices as being sociomaterial in their composition and as requiring an analysis that remains impartial to humans, non-humans and their actions. Recently, Suchman (2007) has argued that in the last twenty years a growing corpus of STS-informed studies of sociomaterial practices demonstrates:

> *how capacities for action can be reconceived on foundations quite different from those of a humanist preoccupation with the individual actor living in a world of separate things.*
>
> (Suchman 2007, p.261)

The rest of the chapter is divided in three sections. Section 2.1 approaches the notion of *assemblages* as the overarching analytical frame of the thesis. It goes on to discuss how heterogeneous entities[5] that comprise assemblages are formed and how they gain and/or lose their capacity to act. Section 2.2 deals with the notion of *reconfiguration* and approaches it as an effect that takes place within and along assemblages. It also discusses the notion of *transformation* and approaches it as a key process in assemblage reconfiguration. Section 2.3 describes the rest of the aforementioned notions that deal with the role of objects within professional collaborations. In doing so it explores the contribution of each notion to the analysis of assemblages and to the heterogeneous entities that constitute them.

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[4] The thesis approaches the words "cooperation" and "collaboration" as having similar meaning. As a general rule, the thesis uses the word collaboration. However, one more criterion is applied, especially in the theory chapter. This concerns the literature that this thesis draws on for discussing cooperation and collaboration. For example, Star and Griesemer (1989) use the term cooperation while Ewenstein and Whyte (2009) use the term collaboration. Within this chapter the work of these and other relevant authors is discussed by following the terms that they already use. When relevant, further clarifications are made.

[5] The thesis's approach to non-humans lies in ANT. For the thesis non-humans can be, artifacts (e.g. books), natural phenomena (e.g. rain), technical phenomena (e.g. electricity breakdown), parts of the human body (e.g. bladder), concepts (e.g. quality) and so on.

2.1 Assemblages [6]

One point of departure for addressing the notion of assemblages is the work of Deleuze and Guatarri.[7] The following brief and contemporary reading of Deleuze and Guattari's use of assemblages belongs to Anderson and McFarlane (2011) and provides some initial help for approaching assemblages as an analytical notion. Citing various texts of Deleuze and Guattari, Anderson and McFarlane describe assemblages as a concept extending in two axes. In their reading, the first axis begins from *a collection of qualities, things and relations* and ends in a *collection of languages, words and meanings*. Its effect is the generation of a provisional unity with heterogeneous parts that are not fully determined. The second axis *involves a distinction between (re)territorializing and deterritorialising movements as heterogeneous parts come together and come apart* (p. 125-126). Within the scope of this thesis the above axes illustrate the following interesting point: an assemblage is an entity that is continuously composed by *not fully determined* heterogeneous parts. Taken as an analytical notion assemblage allows the description of how heterogeneous entities are composed and what effects they generate.

Here it is worth mentioning that the composition of heterogeneous entities can also be thought as form of configuration. However, in contrast with assemblages, configuration provides limited analytical scope for addressing how the effects of interrelated and heterogeneous entities are generated. An expression that has been used in STS-informed literature and hints to the generation of such effects is that of "coming into being." Section 2.2 proposes that the notions of reconfiguration and transformation can describe, with greater accuracy than the aforementioned expression, how assemblages are composed and produce agency.

Suchman (2007) and Latour (2007) have also approached the make up of heterogeneous entities. In doing so they have called for attention to the differences of each compositional element and for impartiality about the analytical treatment of each element. Each element is capable of acting and such capacity produces different effects.

According to Law (2004), the notion assemblage appears in the English version of *Thousand Plateaus* (1987) as a translation of the French abstract noun of *agencement* found in the original language of the book (1980). Pickering, in the book *The Mangle of Practice* (1995), draws on Deleuze and Guattari's take on assemblage as a source of inspiration for approaching issues of non-human agency in scientific practice. Early in his introduction he mentions:

> *Scientists, as human agents, maneuver in a field of material agency, constructing machines that…variously capture, seduce, download, recruit, enroll, or materialize that agency, taming and domesticating it, putting it at our service, often in the accomplishment of tasks that are simply beyond the capacities of naked human minds and bodies, individually or collectively.*
>
> (Pickering 1995, p.7)

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6 Sometimes, the formulation "sociomaterial assemblages" is used instead of "assemblages", depending the point that needs to be stressed. For example, sociomaterial assemblages can be used for stressing issues of heterogeneity in the formation of assemblages.

7 STS-informed authors, such as Pickering (1995) and Law (2004), have been dealing with assemblages and, in their work, have been explicitly acknowledging Deleuze and Guattari's approach to assemblages.

The above quote refers to Pickering's point of departure where humans, like scientists, are involved in emergent tasks whose definition partially relies on non-human actors' capacity to act. Then, assemblage can be understood as a notion that allows us to think emergence as a situation where agency is potentially contested *but also* distributed among heterogeneous entities and actor-networks. The message here is that the notion of assemblages allows the approach of agency as a form of question that can be analytically answered. Then, the question of agency is also about the conditions under which relations between humans and non-humans are enacted.

Closer to the notion of enactment is the work of John Law in the book *After Method* (2004). There, he presents and discusses the notion of *method assemblages.* Before doing so, he provides the reader with a definition of the assemblage by maintaining a focus on the enactment of its elements. For Law, an assemblage:

> *…is a process of bundling, of assembling…in which the elements put together are not fixed in shape, do not belong to a larger pre-given list but are constructed at least in part as they are entangled together.*
>
> (Law 2004, p. 42)

Law's quote brings additional focus on the temporal and spatial tensions that accompany assemblages and on the aforementioned issues of emergence. An assemblage is a process that lasts for an unknown period of time. Therefore, its comprising elements tend to be continuously configured and reconfigured. The tension between configuration and reconfiguration has inspired this thesis to tackle agency by focusing on how heterogeneous entities are constituted.

Another scholar, Lucy Suchman (2008), has considered assemblages as *tropes* that enable an understanding of sociomaterial relations and as devices that can also sensitize researchers to analytically approach the relations between humans and non-humans as the basic unit of analysis (p. 150). In this sense, an assemblage is simultaneously a theoretical means and methodological sensitivity. As a theoretical means it suggests that sociomaterial relations are central to the generation of knowledge. It also points to an analysis that is impartial as to whether agency is an effect that is produced by humans and/or non-humans. As a methodological sensitivity assemblage depicts sociomaterial relations as potential units of analysis and invokes the problematization of the (hybrid) practice fields that they may span across.

Here, it is worth mentioning that in earlier STS-informed research the constitution of sociomaterial relations has been approached under the premise that humans and non-humans mutually constitute each other. However, according to Suchman (2007, p. 268) relations between humans and non-humans may span across *multiple* sociomaterial assemblages and each of those relations is potentially subject to asymmetries. These have to do with the idea that *humans shape non-humans in potentially different ways from those that non-humans shape humans*. This observation has inspired the thesis' approach to assemblages. An empirically informed example can be found later in the thesis (Chapter 4 and Appendix 2) and concerns the use of a disinfection gel by healthcare professionals and other actors, such as parents of young patients. For healthcare professionals the disinfection gel was a means for cleaning toys that were previously used by young patients. For parents of young patients – who did not receive specific instructions of how to clean toys – access to the disinfection gel and its application over used toys resulted in the displacement of seemingly well-established procedures of toy cleaning.

In early STS studies the shaping or constitution of humans and non-humans has been part of methodological discussions and part of arguments stating that non-humans have the capacity to act. It has also been one of the central points of large concepts in STS, such as actor-networks (e.g. Callon 1991), of smaller ones, such as hybrid communities (Callon 2004) and collectives of humans and non-humans (Latour 1999) and, of others that have recently gained interest, such as that of infrastructure-ing.[8] All the aforementioned concepts have explicit and strong relations with ANT. Among those, the more recently developed one is that of infrastructuring. To a great extent, infrastructuring is informed by older metaphors and concepts (e.g. information infrastructures) that are regularly used in the community of Computer Supported Cooperative Work.

Law, Pickering and Suchman do not employ assemblages as their primary analytical notion but their approaches to it reflect some of this thesis's analytical concerns: 1) the temporality of spaces during which heterogeneous entities are formed, 2) the coherence, interdependence of heterogeneous entities as well as the symmetrical approach to them (see also Chapter 3), 3) the generative processes under which heterogeneous entities gain or lose the capacity to act.

Each of those concerns has been considered already in STS-informed literature which has, in turn, equipped the present analysis with the appropriate vocabulary for their discussion. Additionally, it is worth mentioning that such vocabulary belongs to STS, but it is also field-specific. Below, a select literature that deals with the above-mentioned concerns is presented.

The notion of temporary spaces is met in various STS-informed texts. Even though various researchers have employed the notion for addressing quite different subjects, it allows one to conceptualize processes that produce temporal and spatial effects. For example, Hor et al. (2014) employ this notion to describe the efforts of some clinicians to generate temporary conditions in common hospital areas (e.g. corridors), where they could discuss crucial aspects about their patients' health conditions, while allowing only particular interruptions by their peers and others. Drawing on an empirical case of indoor climate Clausen and Gunn (2015) use temporary spaces as a framework. They note that temporary spaces is a useful notion for bringing attention towards the *configuring, political and discursive elements of distributed spaces* (p.87). The notion allows one to suggest how the formation of heterogeneous entities takes place across time and in various spaces. In a way, the notion challenges a linear approach to the processes through which heterogeneous entities are formed.

The formation of heterogeneous entities is a quite old and well-covered topic in STS and various attempts have been made to analytically describe such a process. One of them is the aforementioned notion of *collectives of humans and non-humans* (Latour 1999), where a

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[8] For the purpose of clarity I will distinguish infrastructures and infrastructuring here. A recent shift has begun to take place from infrastructures to infrastructur-*ing*. The concept of infrastructures has been discussed in depth within STS. Scholars such as Bowker and Star (2000) have argued in the past for the sociomaterial nature of infrastructures. Currently, STS-informed scholars have used the notion of infrastructuring for bringing additional attention to the dynamics that take place when infrastructures are constituted and displaced. The point here is that infrastructuring can be seen as a recent addition to an STS-informed vocabulary that can be used for understanding how heterogeneous entities are constituted.

It also needs to be clarified that this thesis employs assemblages as its main analytical notion. However, infrastructuring has also been pursued as a notion in the article in appendix 1. The article was written independently from the overarching body of the thesis and constituted a response to a particular call for articles about "infrastructuring and collaborative design".

collective can modify its composition (and therefore be displaced) by articulating different associations with humans and non-humans. Such articulation comprises of the processes of translation, enrollment, crossover and mobilization.[9]

The coherence and interdependence of heterogeneous entities has also been described in ANT literature as an issue of durability that involves the development of programs and anti-programs of action (e.g. Latour 1990) and as an issue of mutual relations between actors (Latour 1992). The temporal qualities that accompany the notion of assemblage (it becomes reconfigured over time) allow a discussion of coherence and interdependence in other ways than older dualist approaches. Mol (2002) has approached the generative processes under which heterogeneous entities gain or lose the capacity to act as processes of enactment. In doing so, she has tried to deal with the contested history of entities (she calls them objects), as well as with their complex presence that may differ from site to site.

The notion of assemblages has the potential to guide an analysis toward issues of temporality, transformation and agency, and thus enables one to deal with the interdependencies between those. In this way, an assemblage can be thought as an analytical apparatus. The following approach to assemblages by Marcus and Saka (2006) provides a summary of the above concerns. This can also be considered as the point of departure for the thesis's analysis (Chapter 4):

> *Assemblage is…a resource with which to address in analysis…the modernist problem of the heterogeneous within the ephemeral, while preserving some concept of the structural…. [Assemblage] in its material referent invests easily in the image of structure, but is nonetheless elusive. The time-space in which assemblage is imagined is inherently unstable and infused with movement and change. Assemblage thus seems structural, an object with the materiality and stability of the classic metaphors of structure, but the intent in its aesthetic uses is precisely to undermine such ideas of structure. It generates enduring puzzles about 'process' and 'relationship' rather than leading to systematic understandings of these tropes…It offers an odd, irregular, time-limited object for contemplation.*
>
> (Marcus and Saka 2006, p. 102)

Below, two written works are briefly presented, each of which entails a concept that partially draws on assemblages: The first is Alex Wilkie's concept of user-assemblages and the second is Cornelius Shubert's concept of sociotechnical ensembles.

Wilkie, in his PhD thesis (2010), draws on Deleuze and Guattari's work on assemblages for approaching user-oriented considerations in professional design practices. In doing so, he develops the concept of *user assemblages*. The workings and conceptual references of the notion are of particular interest for this thesis since, according to Wilkie, they enabled him to *foreground the role of non-humans in design practice* (p.192). The work of Wilkie is relevant to

[9] An additional analytical notion that Latour presents and helps the explication of those processes (especially if they have taken place in the past) is the reversible black-boxing. Latour (1999) uses reversible black boxing as a seven-step model (see p. Latour 1999, 184 for a diagram) for sensitizing his readership to identify the processes through which artifacts come into being. This includes processes that render artifacts as stable and durable for those who use them. In addition to the development of artifacts reversible black boxing can also be used for helping one to describe how heterogeneous entities are formed (and potentially displaced).

this thesis, as he outlines the relations between non-human agency and user-centered design practices. User-centered design implies, almost by definition, some form of collaboration. Wilkie approached user-centered design practices by doing ethnographic research at a large firm working in the production of medical devices. In his analysis he explicates how sociomaterial practices were developed in the firm and the role of designers within those practices. According to Wilkie, issues of representation, expectation and anticipation, scale, sociomaterial innovation and invention are at play when designers consider: 1) the future of the technological devices that they aim to design and 2) the potential users and uses of the devices. Wilkie concludes that:

> *…human agencies are formatted in design; human agency is diverse and a consequence of particular sociotechnical orderings; the practice of design means shaping human agency and not responding to it, and…discussions about agency must include an appreciation of the preceding, in order to responsibly define the (ethically) desirable type of human agency.*
>
> (Wilkie 2010, p. 204)

The above quote reflects findings that are based on the analysis of *professional* design practices - something that does not directly concern the analysis of this thesis. However, the quote allows for an analytical approach towards non-human agency in collaborative work that takes place in healthcare. Wilkie's approach to design, through notions such as formatting, ordering and shaping are also helpful for describing assemblages.

Cornelius Schubert (2007) has approached some forms of collaborative work that relate to patient safety under the notion of sociotechnical ensembles. He develops the notion of sociotechnical ensembles in tandem with findings from an ethnographic study of cooperation among clinicians in the Operating Theatre (OT). He describes three different modes of cooperation in the OT: routine, improvisation and compensation. Approaching these as the empirical scope of sociotechnical ensembles Shubert discusses the effects of ensembles in terms of 1) the establishment of reliable processes and 2) the distribution of knowledge. He argues that the OT can be understood as a hybrid network that operates among many others within a hospital. What is of interest here is the establishment of reliable processes and the distribution of knowledge. These two aspects can support an analysis of how assemblages work, by allowing one to consider when and how reliability and distribution of knowledge entail forms of non-human agency.

2.2 Reconfiguration

This section deals with the notion of *reconfiguration*[10] as it relates to assemblages. It is useful for addressing how assemblages are configured *across time* and how this may affect their agency. In doing so, the section focuses on two particular approaches to reconfiguration. The first is Knorr-Cetina's work in the book *Epistemic Cultures* (1999) and the second is Lucy Suchman's work in the book *Plans and Situated Actions: Human-Machine Reconfigurations* (2007). An understanding of assemblages as potentially reconfigured provides a partial, yet substantial, part

[10] Periodically, other STS-informed scholars, such as Orlikowsky (2007) and Callon and Rabeharisoa (2003), have employed the notion of reconfiguration in their analyses.

of this thesis's analytical frame. Reconfigurations, seen as effects, allow one to understand how humans and non-humans are transformed.

Reconfiguration as a source of thinking transformations of humans and non-humans

Knorr-Cetina (1999) employs the notion of reconfiguration for bringing into purview the sociomaterial transformations through which natural phenomena become elements of scientific work practices in laboratories. While setting the stage for a detailed analysis of laboratory work she clarifies that humans within laboratories lead the transformation of natural phenomena into scientific objects. This can be understood as an example of configuration. However, she also adds that non-humans – the scientific objects that come into being – transform humans, and in particular their role as scientists. In Knorr-Cetina's vocabulary subjects and objects are mutually transformed. According to Suchman (2007) this transformation is done in potentially different ways. Thus, transformation generates different effects that altogether constitute a reconfigured assemblage.

In light of her research and findings about laboratory work Knorr-Cetina (1999) calls for an extension of the notion of reconfiguration in two directions. The first has to do with the *ongoing work of instituting specific differences* and the second with the *work of boundary maintenance* (p. 44). Both extensions are meaningful for this thesis. The first direction has allowed the analysis to unravel some complex processes through which particular safety practices become a contested matter among various and distinct groups (e.g. clinicians and non-clinicians). The second direction, boundary maintenance, has allowed the analysis of those processes where explicit boundaries become contested. This is done through the performance of boundaries in daily work by hybrids of humans and non-humans. Then, the maintenance of boundaries concerns their potentially contested nature but also the *boundary work, though which a given entity is delineated as such* (Suchman 2007, p. 283).

Knorr-Cetina's approach to assemblages brings attention to the definitions that human actors make for themselves (or refer to each other) and allows the appreciation of those as traces of the assemblages that they constitute. Suchman's attention to the different effects that transformations between humans and non-humans may generate broadens the scope of assemblages. Finally, changes of definitions that could potentially occur over time and include relations of humans and non-humans can be understood as traces of an assemblage reconfiguration.

Transformation as a process of assemblage reconfiguration

Many different transformations can be parts of an assemblage's reconfiguration. Their amount and nature depends on the definition of change given by various heterogeneous actors. These actors may initiate such change or they might be excluded from such process - either because they oppose or because they are forced to remain excluded. The notion of transformation cannot be a relevant analytical means for only those actors partaking in changes which, in turn, signal the emergence of a reconfigured assemblage. The notion is also relevant for the analysis of the those human and non-human actors whose nature changes even if they are excluded by the workings of an assemblage. In this way, the notion of transformation enables this thesis to focus on and discuss the premises under which actors are included and/or excluded in assemblages. In a way, then, transformation problematizes early actor-network analyses that were led by the actions of dominant actors (see also Section 2.3). It also relates to more contemporary extensions

of actor-network analyses that have been supported by concepts such as multiplicity (Mol 2002) and infrastructuring (e.g. Pipek and Wulf 2009). What these concepts share is a focus on how sociomaterial entities, such as diseases and infrastructures, are constituted in multiple yet distinct spaces and temporalities. Similarly, the idea that an assemblage can become reconfigured hints that some constituents of an assemblage might be transformed at a different time from others. Thus, the reconfiguration of an assemblage may also take place when only some of its constituents become transformed.

Non-human mediation

Knorr-Cetina has argued that humans define themselves and each other according to some qualities of the objects that mediate their interactions and their communication. The thesis assumes that such principle applies for care delivery settings, where communication and collaboration among healthcare professionals is of primary importance for patient safety (Iedema et al. 2013). Then, the role that non-human entities play in collaboration within healthcare becomes an analytical question of non-human mediation. Suchman's (2007) approach to the notion of ordering is a helpful resource for scoping non-human mediation in reconfigured assemblages. Here it is worth mentioning that even though Suchman's book *Human-Machine Reconfigurations: Plans and Situated Actions* deals with both notions, reconfiguration and ordering, it does not explicitly address relations between them. However, her chapter *Plans Scripts and other Ordering Devices* (p. 187-205) provides some inspiration. There, she suggests that procedures, plans, templates and categories can be thought of as devices that partake in the production of ordering in sociomaterial sites. The chapter foregrounds the mediation of particular artifacts in the relation of human actors with procedures, plans, and categories. A focus on procedures and plans is important for analyzing how healthcare professionals collaborate and communicate in situations that concern patient safety. For example, error reporting in hospitals can be thought as a set of activities that concern different groups of healthcare professionals (e.g. nurses and doctors). Briefly put, the reporting of errors requires from healthcare professionals to attend to particular procedures (e.g. report errors that have happened in the past) and to allocate errors in electronic reports according to categories, such as that of "near misses". On the one hand, error reporting mediates the ways that different groups of healthcare professionals relate to patient safety in daily work. On the other hand, error reporting is just one among many ways that healthcare professionals relate to patient safety (e.g. hygiene protection) and that safety is actually ensured. The message here is that an activity, such as error reporting, can be part of a particular ordering that deals with a particular aspect of safety but its relevance and usefulness to patient safety depends on other practices that deal with safety and are not part of this ordering (e.g. disinfection of hands).

Liminal spaces as one example of reconfiguration

This part draws on a particular article (Iedema et al. 2010) that deals with the communication of clinicians at the corridors of a hospital. The short presentation that follows uses corridor communication as a case of reconfiguration where non-humans reconfigure the work of clinicians. Iedema and colleagues drew on the notion of *liminal spaces* for analyzing interactions

that took place among clinicians at a bulge of a corridor. This type of interaction had an impact on patient treatment and safety.[11]

Drawing on Turner's (1957) definition of a liminal space Iedema and colleagues approach corridors as spaces that do not contain inscriptions of any particular activity or rules but as '*fill-in' or 'add-on' spaces that fall outside the geographic grid of identifiable social and organizational events, conducts or functions* (Iedema et al. 2010, p. 24). The authors suggest that when clinicians met in a corridor and used its bulge to communicate quickly they interacted in ways that they would consider as inappropriate or strange if such communication would take place in other places within the hospital, such as next to a patient's bed. The analysis of three particular incidents that took place at the corridor's bulge illustrated situations where clinicians mingled by lingering at the walls that constituted the bulge and communicated by ignoring rules that accompanied local hierarchy; asking seemingly naïve questions to their superiors and reflecting upon their own behaviors toward patients. Discussing the effects that the bulge generated in clinicians' interactions, Iedema and colleagues mention:

> *[The corridor bulge] frees clinicians from the expectations inscribed into the rest of the clinic…It enables clinicians to position themselves momentarily as 'outsiders' to their own workflows. This creates the possibility for clinicians to confront and reflect on their work from a perspective that has a 'room', literally and figuratively, for the various uncertainties and contradictions that form integral and inescapable parts of clinical work but that usually remain unexpressed in cross-specialization exchanges…The corridor bulge offers a spatial resource for dealing with workplace complexity.*
>
> (Iedema et al. 2010, p. 34)

The above quote brings attention to the ways that the material properties of particular areas, such as a bulge, may mediate the communication between clinicians, and thus contribute to the reconfiguration of the latter. According to Iedema and colleagues the bulge hosted interactions but it also "freed" and enabled clinicians to undertake news roles in their in-between interactions. While such vocabulary is case-specific, it has inspired particular parts of the thesis' analysis. For example, the role of the bulge in the temporal positioning of clinicians as outsiders to their own work can be thought of as a form of non-human mediation that allowed clinicians to become more empathetic to each other's work. Confrontation and reflection may also be thought of as parts of a negotiation process that was mediated by the bulge. Finally, the room metaphor and its relation to uncertainty and contradictions inspires a focus on the co-existence of elements belonging to assemblages. On the one hand such elements may constitute local contingencies and, on the other hand, these may allow the continuation of collaborative work under an, at least temporary, consensus.

[11] An example of the safety aspect that is presented in the article of Iedema et al. (2010) is a discussion between a doctor and occupational therapist. This entailed considerations about moving a patient from his current to a new mattress while avoiding the making of bedsores.

2.3 Approaching the agential role of objects in collaborative work

This section discusses the notions of boundary objects (Star and Griesemer 1989), intermediary objects (Boujut and Blanco 2003) epistemic objects (Ewenstein and Whyte 2009, Knorr-Cetina 2001) and conscription devices (Henderson 1999). It does so with the purpose of presenting a vocabulary that can support the analysis of mediation as a *transformative potential* that non-human actors (e.g. material and digital artifacts) may have or acquire in an assemblage.

An approach of non-human agency as a potentially contested matter (which can be temporarily acquired or lost) *and* as transformative potential that is entailed in heterogeneous entities, requires attention to the constitution of agency. Such issue can be dealt with support from the vocabulary that has informed the development of each of the aforementioned notions. Moreover, these notions share a common point of departure. This can be shortly described as 1) the empirical study of professional collaboration and 2) an analytical focus on the mediating role of objects in collaboration.[12]

Object-oriented notions in light of collaboration at work: origins and brief overview

Before proceeding to the presentation of each notion, it is worth acknowledging the role of boundary objects in the development of intermediary objects, epistemic objects and conscription devices. All these notions were developed *after* Star and Griesemer's article on boundary objects (1989) but entail explicit relations to the notion of boundary objects. The articles that have contributed to the development of each notion refer to such relations as a critical approach to Star and Griesemer's text (for various reasons). Some articles identify differences between the notions and some others identify similarities. Differences between all other notions except boundary objects (e.g. between intermediary and epistemic objects) are not explicitly mentioned by the literature that is used below. An attempt to identify those differences falls outside of this section's aim and scope. The aim of this section is to review the vocabulary that has supported the development of each notion, and then to describe how this supports the thesis to deal with the aforementioned issue of mediation.

The review of each notion that follows in the next subsections also attends to the differences between boundary objects and the rest of the notions. This is done in two ways: Firstly, each of the following subsections (except that of boundary objects) addresses the differences that are mentioned and discussed by the cited authors. Secondly, each subsection addresses some differences that outline the development of each notion.

Boundary Objects

Star and Griesemer (1989) developed the notion of boundary objects in light of an empirical study that was informed by historical material and concerned the collection and preservation of animals for the Museum of Vertebrate Zoology in California at the beginning of the century. They did so by focusing on the various perspectives upon and practices of the collection and preservation of specimens by amateur naturalists, taxidermists, professional biologists, philanthropists and others. Analyzing how cooperation between those actors was taking place *without consensus*, Star and Griesemer identified some artifacts that mediated such cooperation.

[12] Of course there are other theoretical notions that have been developed by authors with an interest in the role of artifacts in collaborative work, such as the concept of Boundary Negotiating Artifacts (Lee 2007). However, the thesis's analytical needs are satisfied by the chosen ones.

A variety of artifacts enabled and/or constituted cooperation as problematic for the implicated actors. Such variety included specimens, field notes made by naturalists, the museum where the biologists worked, the territory of California that served as a field for animal trapping by various and competing groups and other artifacts. Star and Griesemer addressed those artifacts as *boundary objects* and defined them as:

> *…both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual site use. These objects may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation.*
>
> (Star and Griesemer 1989, p. 190)

The above definition has attracted many researchers to apply the notion in various research fields (for an extensive review see Trompette and Vinck 2009 and 2010) as well as to use it in an instrumental way and search for "effective" boundary objects (e.g. Carlile 2002). This thesis is interested in the premises and vocabulary upon which the notion was developed. The discussion that follows below, takes the form of two observations and highlights the usefulness of boundary objects for the thesis's analysis. Some of the points that are raised right below are elaborated later in the same section, with the help of a particular research article (Nicolini et al. 2012) which has approached boundary objects as an element of a broader object-oriented conceptual framework.

The first observation concerns the ontological approach to objects that is reflected in the above-cited definition of boundary objects. Star and Griesemer's definition gives a good sense of the qualities of boundary objects. They are plastic enough, they can adapt to local needs, they are robust and so on. These are helpful resources for describing how particular artifacts or some of their material properties mediate interactions within assemblages. Then, a first reading of the definition reveals a vocabulary for describing artifacts that have *already* acquired an agential status. However, a second reading of the definition may also generate questions about how objects *become* plastic enough and how they adapt to local needs. Thus, the definition of boundary objects entails a vocabulary for approaching and describing how artifacts are transformed into boundary objects.

The second observation concerns Star and Griesemer's development and use of boundary objects for describing *social worlds*. Interestingly, early in their article, the authors (1989, p. 289-290) position their work as reconciliation to the managerial critique that was put on early approaches of actor-networks (In doing so Star and Griesemer cite Callon 1986 and Latour 1988). Briefly put, such critique concerned the way that actor-networks were empirically studied and described. Early descriptions of actor-networks maintained a focus on particular perspectives and practices that often belonged to the most powerful actor of the described actor-network. However, in later parts of the same article Star and Griesemer clearly abandon actor-networks and refer to social worlds. While the term network appears sporadically in their analysis the authors do not make further clear references to the implications of the non-human agency of boundary objects. The paradox that the above observation raises is that the development of boundary objects was based

on the premise that artifacts mediate interactions between humans but the use of boundary objects as an analytical means does not clearly consider the agential implications of such mediation. The question that arises is whether boundary objects can inform the analysis of entities, such as assemblages, that have a capacity to act. This thesis's approach to such question is informed by early approaches to ANT (e.g. Callon 1991). Then, an entity that has a capacity to mediate interactions, like a boundary object, it actually translates the elements that partake in them. In turn, such entity may also become translated. Therefore, another important aspect of boundary objects – for this thesis – is their ability to bring attention to how boundaries in assemblages become constituted, contested and displaced.

The rest of the notions are discussed below because the vocabularies upon which they were developed can also support the analysis of non-human mediation in assemblages. The different vocabularies that each notion introduces help the analysis to the extent that these vocabularies can complement one another. In this respect the differences between and definitions of each notion are of less importance for the analysis that follows in Chapter 4. The explication of differences between boundary objects and the rest of the notions will be done with the purpose of making more clear how agency becomes a contested matter (it can be temporarily acquired or lost) and a transformative potential of heterogeneous entities. It is the ideas that have driven the development of each notion that have been useful for the analysis. It is not the aim of the thesis to make use of all notions equally and exhaustively.

Intermediary Objects

Boujut and Blanco (2003) drew on the notion of intermediary objects, which was initially developed by Vinck and Jeantet (1995), for studying the development of design engineering-related representations and the sharing of those within and across departments of a large truck firm. In doing so, Boujut and Blanco also explicated some aspects of intermediary objects.

Focusing on the development of a Computer Aided Design (CAD) model of an axle, the authors studied the ways in which such model mediated the work between the manufacturing department and design experts. In their analysis, the authors mention that such a model is a boundary object which allows and/or prevents different groups to work and they continue by stating that the same model is also an intermediary object. Unfortunately, after such indication the authors do not make any further reference to boundary objects. According to the authors (p. 210-211), *intermediary objects are also intermediate states of the product if we consider the objects as mediators translating and representing the future product.* For them, an object, such as a CAD model of an axle, entails multiple representations and refers to the intermediate states of the axle-as-a-product, such as a handmade draft of a detail and a printed copy of a two-dimensional representation of the axle.

Intermediary objects is a relevant notion for approaching the development of artifacts that become transformed over time, such as scenarios of critical events that are used for healthcare simulation sessions (see Chapter 4). The idea that artifacts are intermediate states of something broader is a useful addition to the more static approach that the notion of boundary objects offers.

Boujut and Blanco go on to analyze the CAD model and in doing so they explicate three characteristics of intermediary objects: *mediation, translation or transformation and representation* (p. 211).

Discussing the notion of mediation they suggest that objects which are used among various human actors and are aimed at supporting collaboration need to be "open" throughout all their intermediary stages. The authors argue that participants in the design process need to have access to objects that contain the rationale and previous steps with which earlier versions of the axle came into being. The openness of objects is a sensitizing device that helps the analysis to consider the development of artifacts by attending to whether these become relevant for many actors and, if so, then how open are they to multi-actor appropriation.

Discussing the notions of translation and transformation the authors mention that a translation of a CAD model to a three dimensional object is a process that is undertaken by many actors and requires some shared knowledge. Part of such knowledge, the authors argue, is a common explanation of the choices that are made and this also leads to a common understanding of the process under which all actors are involved. Then, objects, such as the CAD model and the three dimensional object, are the traces as well as the outputs of the design process (p. 211). This way of approaching translation allows the explication of shared aspects, such as knowledge generation among actors.

Finally, the authors argue that objects, such as the aforementioned, are representations of the final object and of the design process. The authors bring attention to the limitations that concern the communication between those actors who are implicated in the development of the final object (the axle). Different aspects of the final product can be described with support from a CAD model and different ones from a three dimensional object, such as a prototype. The idea of representation is interesting because it brings attention to the material properties of objects and generates analytical questions on how the materiality of a particular object becomes crucial for its transformative potential.

Boujut and Blanco's approach to the development of intermediary objects shares some similarities with the vocabulary that Latour (1999) employed for explaining the phenomenon of a circulating reference. While the notion of circulating reference is not explicitly used in the analysis of this thesis it brings some further clarity about the transformative potential of objects. More particularly, it allows one to understand the trade-offs that take place between the continuous development of objects and their contexts of use. Latour used the concepts of transformation, mediation and representation for examining how a topographic sample of Amazonian soil becomes an element within topographic scientific concepts, graphs, scientific articles and calculations. He called this a transformation of the world into words (and vice versa) and described it as a *circulating reference* phenomenon. Drawing on empirical material from his participation in a topographic field trip, Latour examines the sociotechnical processes in which various scientists work with a piece of soil either individually or as parts of interdisciplinary teams. Theorizing upon such processes he argues that locality, particularity, materiality, multiplicity and continuity transform into compatibility, standardization, test calculation, circulation and relative universality. He calls this a *reduction process* and the way backwards an *amplification process*. Central aspect in the circulating reference phenomenon is that both transformations, the reduction and the amplification, concern *the status of non-human actors at a given time and space*. This is of primary importance for understanding how objects reconstitute and displace boundaries. The transition or transformation of some of the non-human actors' properties in either process requires human actors to pay certain prices that concern conventions such as *time, space, cooperation* and *knowledge*. The development and treatment of conventions

by human and non-human actors can be understood as processes where boundaries are formed and displaced.

Epistemic Objects

Ewenstein and Whyte (2009) draw on the notion of epistemic objects and explore collaboration across professionals. By drawing on an empirical case on the design of a herbarium extension, they attend to the emergence and potential *incompleteness* of objects that mediate collaboration between various professionals who have different approaches to the design process: architects, traffic service and external environment engineers, landscape consultants and other stakeholders. In doing so the authors focus on visual representations (e.g. handmade quick sketches) and bring attention to the ways that such artifacts are developed in and/or passed across interdisciplinary teams. Their analysis foregrounds the multi-actor work that is put into the making of a particular sketch at different times and such work is approached as a *collaborative knowledge practice.* A central aspect of such practice is that the objects that mediate it are never fully completed, they raise questions for human actors and *acquire an almost agential role, becoming non-human actants* (p.22). These observations are helpful for stressing the point that the agential role of objects does not only concern the formation and reconfiguration of assemblages but also the composition of practices. Ewenstein and Whyte's approach to epistemic objects is additionally interesting because the latter concern modes of collaborative work that are close to those that are examined in the analysis that follows later, in Chapter 4.

The relation between practices and epistemic objects has been addressed by Knorr-Cetina (2001) in her chapter *Objectual Practice*. Here it is worth taking a short detour for addressing some of the reasons that epistemic objects relate with practice. This will allow the explication of a particular difference between epistemic and boundary objects. Drawing on empirical material on scientific work at molecular biology laboratories, Knorr-Cetina developed the notion of epistemic objects. In doing so, she addressed a challenge regarding the analysis of practices occurring when scientists were confronted with problems that required them to become creative and not only to follow routines. Early in the book chapter, (p. 184) Knorr-Cetina asks: *What characterization of practice might make the notion more dynamic and include within it the potential for change?* Then, she goes on to suggest that there is a significant disassociation between *self and work* which needs to be conceptually addressed. In doing so she proposes the notion of epistemic objects.

Boundary objects and epistemic objects entail two different approaches to practices. Star and Griesemer (1989) developed boundary objects by attending to natural history work (p. 408) and to the objects that were produced by sponsors, theorists and amateurs as a matter of collaboration between human actors that comprised social worlds. Moreover, they focused on the progress and conduct of work that departs from human actors. In contrast, for Knorr-Cetina (2001) the point of departure for developing epistemic objects is the idea that scientific work in laboratories is a result of tension and confrontation between scientists and the objects of their work. These, for Knorr-Cetina, can also be non-human entities. She goes on to approach practices *as results* that are partly produced by objects that mediate the work of actors. This approach allows the analysis of this thesis to consider the constitutive role of objects to practices and assemblages. The notion of epistemic objects can support the understanding of how the development and use of particular artifacts might reconfigure the practices of actors that constitute an assemblage.

Following Knorr-Cetina's process-oriented approach toward practices, Ewenstein and Whyte (2009) bring into purview the actions of engineers while the latter incorporate visual representations into their work. Engineers refer to, point at and touch representations of incomplete objects of design. The quote that follows, reveals Ewenstein and Whyte's positioning of epistemic objects in relation to boundary objects:

> *By contrast with recent descriptions of boundary objects, which mediate knowledge work in particular instances at given boundaries, [epistemic] objects reflect a knowledge development process that proceeds in an ongoing and dialogical way; embodying a lack, raising a question, begging an answer, unfolding, developing a lack elsewhere, raising new questions, and so on. While the boundary object is relatively stable and concrete, the epistemic object is relatively dynamic and abstract, comprising cascades of unfolding instantiations.*
>
> (Ewenstein and Whyte 2009, p.27)

The above quote provides a vocabulary that concerns the mediating role of objects and which does not restrict one to predetermine what effects such those objects generate for the implicated actors.

<u>*Conscription Devices*</u>

Henderson (1999) has introduced the notion of *conscription devices* and has used it together with the notion of boundary objects in order to study the *interactive construction of sketches and drawings.* Her study took place at a medical device manufacturer and her analysis concerned the transformation of hand-made sketches into technical drawings. In doing so, Henderson brings into purview a series of decision-making processes about the development of a new medical instrument. In her study she approaches sketches and drawings as conscription devices that *enlist participation* and as boundary objects that *afford multiple readings*.

Henderson's text brings attention to the material qualities of various artifacts that enable cooperation. One type of artifact that she follows is a three dimensional *prototype.* According to Henderson, such artifact entails information that relates to its touching and it constitutes kinesthetic or *fingertip knowledge* (p. 112-113). The vocabularies that each actor employs to express and communicate to others such knowledge become layers of meaning that are inscribed in objects that constitute an initial prototype, subsequent versions of it and the final product. Human actors involved in the production of prototypes employ vocabularies which include the notions of feasibility, function and production possibilities in order to describe the qualities *of the final product*. These wordings are examples of how actors approach artifacts while taking for granted the capacity of such artifacts to influence the design process. Thus, the material properties of artifacts enlist participation of various actors, while invoking the development of vocabularies that refer to professionals and their knowledge mediated practices. In contrast with boundary objects, the notion of conscription devices highlights the processes and costs through which artifacts become mediators of collaboration. However, the notion of conscription devices does not bring focus on the multiplicity of each actor that constitutes collaboration. It rather focuses on the immediate events that take place during collaboration.

The section rounds off by shortly reviewing a particular article (Nicolini et al. 2012) that concerns the role of objects in cross-disciplinary cooperation. The article presents a *pluralist theoretical framework* which is composed by three object-oriented notions. While this article does not only discuss non-human agency, it has offered inspiration and insights to this thesis's analytical approach to objects.

Considering the agential and multiple role of objects in cooperation

Nicolini et al. (2012) make a threefold argument: Firstly they describe the elements of an analytical framework that deals with the roles that objects play in cooperative work according to four different notions: boundary objects, epistemic objects, activity theory and infrastructures. Secondly, they argue that different theoretical lenses allow for the analysis of the transformations of objects that partake in cooperative work. Finally, they argue that such pluralist perspective allows them to understand the sources of conflict and potential breakdown in collaboration (p. 613). Their argument is supported by an empirical case of cooperative work towards the development of a bioreactor, which involved scientists from various disciplines. The analysis of the article is separated in four distinct parts and each part deals with a particular set of empirical material relating to one of the four notions.

Referring to the employment of a pluralist approach to objects Nicolini et al. (p.625) mention some aspects of their framework: 1) The use of different notions is fruitful to the extent that they shed light on different aspects of an object's role. 2) The use of different notions under a framework-oriented approach allows a more detailed examination of cross-disciplinary cooperation than an analysis that is supported by a single notion. 3) The framework can be used to trace the transitional status of the objects under analytical focus.

Drawing on the analysis of the bioreactor the authors propose a categorization of objects as primary, secondary and tertiary. Tertiary objects, such as buildings furniture, documents and computers, constitute the infrastructure upon which collaboration takes place. Secondary objects, such as representations of artifacts (e.g. technical drawings) facilitate or prevent collaboration. Primary objects are those that trigger collaboration and collaborative work.

Two interrelated issues have inspired this thesis but have also led to a choice of a multiple, rather than a pluralist approach to object-oriented notions. Both issues have to do with the ways that different notions can support an analysis. Nicolini et al. did so by examining a particular set of data (e.g. an excerpt of a discussion between scientists) under one notion and then they took another set of data and examine it in light of another notion. This approach entails specific premises that concern the inclusion of non-human agency into an analytical account. For Nicolini et al. non-human agency is a premise and a matter of positioning. They use non-human agency for arguing that practices, in their case collaborative practices, have a sociomaterial nature and *therefore* objects need to be approached as actors. In more harsh terms, this approach to non-human agency renders objects as matters-of-fact for the reader. In this thesis, the analysis of non-human agency is a premise *but it is also a gate* that allows the exploration of whether, how, when and for how long heterogeneous entities acquire agency. This thesis employs the vocabularies of the different object-oriented notions for analyzing the empirical material that support it and for exploring the durability and sturdiness of non-human agency.

3. Methodological considerations and methods

Introduction and structure

This chapter presents the thesis's empirical approach to *patient safety practices*. Such approach has its grounding in interpretative research (Schwartz-Shea and Yanow 2012) and focuses on the interactions of healthcare professionals working for the Danish healthcare system (see also Chapter 1, Section 1.6). The most notable elements of this approach are listed below:

1) Data are generated through various types of interaction with informants and are not "waiting" to be collected like "mushrooms" (Alvesson and Skoldberg 2009).

2) Interactions with informants are potentially beneficial for them too, since the methods that support those interactions are applied under the aim to allow or encourage informants to reflect upon their own ways of working.

3) The generation and analysis of data about informants' daily work and practices does not lead to the discovery or explanation of a single reality. These are rather geared towards the explication of *potentially multiple, inter-subjectively constructed truths about social, political, cultural and other human events* (Schwartz-Shea and Yanow 2012, p.5).

The study of patient safety practices is further supported by the metaphors *rolling the snowball* and *following the actors*, which have often been mentioned as methodological "principles" within the field of Science and Technology Studies (STS).

According to Bijker (1995, p. 46) *rolling the snowball* is a principle that a researcher may apply in order to identify actors that are relevant for his/her inquiry and object of study. For example, a researcher may ask his/her informants whether they can suggest other potential informants that they find interesting or relevant to the researcher's topic. Then, the researcher has the option to approach the new informants and apply the same principle until his/her informants do not mention any new ones. *Following the actors* refers to the empirical examination of each actor or group of actors, and the explication of how these relate to the researcher's object of study; how they differ from other (groups of) actors; and whether/how/when they share any common preoccupations. Both metaphors have supported the thesis's empirical approach to patient safety practices but have also raised methodological considerations: Where (not) to study patient safety practices? Which actors (not) to follow and to what extent? These questions are used in the sections that follow below as occasions for clarifying the thesis's empirical inquiry as well as for delineating its study object, that is patient safety practices.

The rest of this chapter is divided in three sections. *Following the actors* and *rolling the snowball* are discussed in sections 3.1 and 3.2 respectively. By drawing on various strands of literature, that range from Science and Technology Studies to Human Factors, section 3.1 describes the field site that patient safety practices were studied and section 3.2 describes how the empirical examination of human and non-human actors took place in the field site(s). Section 3.3 presents the methods that supported data generation activities at the field site(s) (see also Chapter 1, section 1.6): participant observations, interviews, participatory engagement workshop and case analyses with support from vignettes and photographs.

3.1 Rolling the snowball…but to what direction?

Data generation took place in various – and physically distinct – settings[13], including a healthcare simulation center (hereafter SIM), two Innovation Units, a mother-child healthcare facility within a university hospital, a surgery ward and others. This scattered generation of data accompanied the course of the PhD project and influenced its research design. The generation of data at various sites came with the overall challenge of identifying the scope and nature of a site. In addition, the relation that each site would have with/to the analysis of patient safety assemblages was also ambiguous. Which *human informants* from each of the aforementioned sites had to be approached (or not)? How the work of informants in one location could relate to the work of others who worked in other locations? Amit's (2000) critical approach to the metaphor of an ethnographer's *immersion* in a field site points to the contested scope and nature of a field site:

> *The notion of immersion implies that "the field" which ethnographers enter exists as an independently bounded set of relationships and activities which is autonomous of the fieldwork through which it is discovered. Yet in a world of infinite interconnections and overlapping contexts, the ethnographic field cannot simply exist, awaiting discovery. It has to be laboriously constructed, prised apart from all the other possibilities for contextualization to which its constituent relationships and connections could also be referred.*
>
> (Amit 2000, p.6)

The above quote mainly refers to the construction of a field site but the phrase *prising apart of possibilities for (its) contextualization* hints to the co-construction of the field-site and the research object. In this thesis' study, such co-construction is approached as form of multi-sited ethnography (Marcus 1995, Hine 2007) where the (empirical) focus is on patient safety practices. Some of the excluded possibilities of contextualization can already be mentioned. These have to do with choices and limitations that have accompanied the research design of this thesis.

One conscious choice was *to not* empirically study the work of local policy-makers toward patient safety improvement. From early on, the main interest of this thesis was in (patient safety) practices that concerned interactions between clinicians in places where care delivery services were offered (e.g. hospitals). While the choice of including/excluding policy making was a clear one there were others, less clear. For example, during the first months of data generation an option for extended fieldwork appeared, which concerned the study of healthcare quality and patient safety specialists' work at a large hospital. After two exploratory interviews and a meeting it became clear that such work was also *not part* of the thesis' interest. This was mostly due to the specialists' concerns with the application of quality and safety models, such as the Plan Do Study Act cycle (Langley et al. 2009), as a response to challenges that they had already determined.

Another choice concerned the position of the patients in the study. After all, an interest in the role of patients and family members has been a recent and central concern for other researchers' approach to patient safety practices (e.g. Hor et. al 2013). However, for this study the generation

[13] One of them is that the PhD project was ethnography oriented, yet not a-priori related to any specific private or public organization.

of data through a direct inclusion of patients and family members has never been an option. This is because the official inclusion of and interaction with patients had as a minimum prerequisite the application to the Danish council of research ethics (a year or more prior to the PhD project's initiation), its positive reply, as well as its appointment of a site to study patients. This thesis approaches patients through the work of other informants, such as healthcare professionals.

The above choices and limitations are examples of the laborious construction of the overall ethnographic site. These illustrated some aspects of a move toward the *prising apart* of all other possibilities that would contextualize the field site. The consideration that is discussed below concerns a complementary move toward the foregrounding of particular interrelations within a field site. The study of patient safety practices within the mother-child healthcare facility (hereafter facility) is taken as an example.

The empirical inquiry at the facility begun with a focus on a particular aspect of safety: young patient hygiene during play activities at particular locations within the facility (e.g. special rooms for entertainment activities). A round of initial interviews and observations with staff revealed that hygiene was an issue for professionals without a medical background (e.g. pedagogues) who engaged young patients in activities of play as well as for clinicians (e.g. nurses) who worked for the hygiene department within the hospital (see also article in appendix 2). While the empirical inquiry brought to the fore various interrelations between clinical and non-clinical work practices, there was only enough time for a further examination of non-clinical work and for a single interview with a clinician who worked in the hygiene department. This resulted into limited options of making non-clinical professionals aware of the hygiene department's views on hygiene practices and vice-versa. However, the engagement of the hygiene department continued at the conclusion of the fieldwork, during a participatory workshop (see also Section 3.3, this Chapter). There, participants that belonged to the facility's top management considered particular aspects of young patient hygiene by drawing on the insights of non-clinical professionals and the hygiene department.

The key message from all the aforementioned considerations is that the engagement of this thesis' multiple sites for data generation entailed overall *as well as* site-specific delimiting choices. These choices constituted a particular multi-site that emerged along the course of the empirical inquiry. Thus, the research design of this thesis remained partially open throughout the empirical inquiry.

The above examples of "laborious construction" illustrated instances where the snowball rolling was a controllable process and a matter of choices. But what happens to research design when the snowball rolling becomes a process with consequences for others, besides the study itself? The remaining part of this section provides some more indications about the direction that the snowball rolled towards throughout the study. This relates to the multi-sited nature of the ethnographic fieldwork that was conducted, the audience(s) that were addressed during the fieldwork as well as the audience(s) that this thesis wishes to contribute to. In her approach to multi-sited ethnography, Hine (2007) uses the metaphor of *crafting* a field site. According to Hine (2007, p. 657):

> *Multi-sited ethnographers craft field sites with an eye to producing appropriate accounts for heterogeneous audiences…Rather than a pre-existing territory in the middle, there is instead an embodiment of tensions, in the ethnographer attempting to*

> *sustain a sense of meaning in the project out of diverse responses and accountabilities…the ethnographer seeks out resonances, finding audiences for whom the study will be recognized as having an adequacy to connect with their concerns. Rather than being inherently recognizable as timely, a study finds an audience through a much more active process.*
>
> (Hine 2007, p.657)

Hine positions the ethnographer at the center of fieldwork and (in-between) the field sites but she also presents the ambiguity that lies between fieldwork, outcomes and the ethnographer's contribution to heterogeneous audiences. In light of such ambiguity, two issues that concern this study can be mentioned.

The first issue relates to the addressing of relevant actors and their occasional transformation into temporary audiences during or right after the termination of the fieldwork. The second issue concerns the "crafting" of audience(s) that might be interested in the outcomes of this study. While the first issue concerned the fieldwork period, the second can be understood as a process that continued after the end of the fieldwork activities (e.g. data generation) and which concerns the entire course of the PhD project. Both issues are discussed right below.

The first issue is illustrated with support from data that were generated during a participatory workshop and which concerned the hygiene of young patients at the mother-child facility.

During a four-hour participatory workshop (see also Section 3.3 of this Chapter) key staff from the facility's management were called to consider young patient hygiene by engaging with empirical material that was generated during this study. Through different activities and forms of empirical material (e.g. photographs, vignettes and quotes) the participants realized that young patient hygiene depended on the work of clinicians (e.g. nurses) and non-clinicians (e.g. pedagogues) and, that such work was spatially shared and temporarily distinct. Such realization led participants to discuss a broader and potential interdisciplinary work practice between clinicians and non-clinicians. The workshop's participants can be understood as a particular audience whose crafting was based on practical considerations, such as the availability and interest of the management's staff on hygiene issues. In the context of the workshop, the approach of the participants to clinical and non-clinical work as a potential interdisciplinary practice can be understood as a process through which another audience was crafted.

This example indicates that the formation of an audience is about the "laborious construction" of the field site, but also about the reframing/reconfiguration of relations between informants that constitute it.

Regarding the second issue, which concerns the crafting of the audience(s) that this thesis aims to contribute to, two interrelated aspects are important: a) The PhD project's aim is to contribute to collaborative design practices, and b) the identification of areas that relate to design practices and are open to being explicated in new ways.

The main idea that guided the PhD project was the empirical study of patient safety practices for the purpose of understanding the constitution of collaborative design practices in healthcare settings. Based on this idea, this thesis aims to contribute to diverse and interdisciplinary fields where design could be a potentially interdisciplinary practice among designers and other professionals. Working toward such aim, the thesis approaches potential contributions to patient safety practices as being of lesser importance. However, some of these contributions become

clearer in the above workshop example and in the co-authored article about the contribution of non-clinicians to patient safety research (appendix 2). The thesis' engagement with collaborative design practices is made through an empirically informed analysis of patient safety practices. Such analysis supports a discussion about how collaborative design practices come into being and what is the role of the professional designer in them. This view is based on the observation that recent efforts towards relating design and patient safety (e.g. special issue on Safety by Design, 2006) address design by relying upon the expertise of designers and not upon that of healthcare professionals. The consequence is a close relation between design and professional designers. Such relation was problematized almost a decade ago within the field of Science and Technology Studies (e.g. Suchman 2002, Suchman 2007). These and other relevant studies have argued for the continuation of design into the contexts of use (see also Chapter 1, Section 1.3). Therefore, the methodology of this thesis provides an approach to interdisciplinary practices of design that emerge throughout the daily and materially mediated work of healthcare professionals, be they clinicians or others, in the context of healthcare.

3.2 Following the actors...but what is an actor?

The metaphor of *rolling the snowball* allowed for a discussion about some considerations that concerned the field site that this thesis drew on for generating data. The metaphor of *following the actors* is used below for considering human and non-human agency (see also Chapter 2) as a methodological issue. *Following the actors* has appeared as a generic methodological approach to human and non-human actors as well as a concern in various texts that relate to STS. In early Actor-Network Theory (ANT) texts (e.g. Callon 1986, Latour 1988) *following the actors* has allowed the study of scientific controversies. The notion has gained attention in light of the analytical consequences that accompany decisions for actor inclusion and exclusion (e.g. Marcus 1995, Latour 2005) and more recently, it has received critique about emerging managerial implications (Vikkelsø 2007).

In a text about multi-sited ethnography, which comes from the field of anthropology, Marcus (1995) provides a variety of options to researchers of *what* to follow while ethnographically investigating multiple field sites. Through an elaborated account (p. 106-110) he suggests that one could follow *the people, the thing, the metaphor, the plot, the biography and the conflict*. As it concerns the methodology of this thesis most of these themes provide an initial basis for considering human and non-human agency. The subsections that follow right below describe how people, things and conflicts were followed. Each theme explicates methodological considerations of non-human agency through short discussions of workplace studies, laboratory studies and studies of patient safety practices.

Follow the people

According to Marcus (1995), the most obvious way of doing fieldwork is by having the researcher follow a particular group of people through observations, interviews and other methods that allow data generation.

This PhD project approached individuals and groups of people *as informants* and the focus was on their multiple relations and engagement with patient safety practices. For example, an informant who was interviewed and observed at the healthcare simulation center (SIM) was a medical doctor, who also instructed healthcare simulations and, did her PhD research on

clinicians' "non-technical skills". During the interview that took place at SIM the informant drew on her practical experiences that she gained from all roles. On the one hand the informant's shared experiences allowed the thesis to gain an understanding of how she, as an individual, dealt with patient safety from different professional positions. On the other hand her insights revealed that there were differences in the ways that clinicians would deal with tasks intended to ensure patient safety (e.g. wearing gloves and gowns) at a simulation room and at an Operation Room (OR). The thesis approached such multiplicity as being inherent in each informant and considered its explication, during fieldwork and afterwards, as an opportunity for generating insights about how safety practices that take place in different workplaces may relate to each other. A general observation that derived from the fieldwork is that the value of such multiplicity is a matter of gradual construction of objects of study within and across field sites. Therefore, it cannot be fully appreciated by the time that data are generated or right afterwards.
In addition, the thesis addressed the multiple nature of informants and their engagement with patient safety at work by drawing support from Nicolini's (2009) approach to work practices:

> *I shall refer to practices as the actual, constantly evolving accomplishment of an object-oriented activity which obtains some durability and diffusion by virtue of being sustained by a social grouping and inscribed in some material or symbolic intermediaries. When I speak of practice I thus always refer to 'practising', real time doing and saying something in a specific place and time which in turn: (i) entails some form of agency, materiality, and history, (ii) depends on other practices to happen, and (iii) produces some form of effect in the world.*
>
> (Nicolini 2009, p.121-122)

Nicolini's approach to work practices[14] has inspired this thesis to approach patient safety practices by keeping an empirical focus on the relations that individuals and groups of people, developed with material and symbolic intermediaries (e.g. artifacts) that constituted their workplaces. Such methodological strategy was also accompanied by a particular approach to the relations between the aforementioned social entities and their intermediaries. According to this approach relations are temporary configurations where humans and non-humans may define each other (see also Chapter 2, Section 2.2).
What may clarify further the thesis's approach to groups of people is Suchman's (2007) critical reading of two STS "classic" texts and their treatment to groups of people. More particularly, she discusses Woolgar's (1991) use of the notion of *configuration* and Akrich's (1992) treatment of the notion of *de-scription*. The critique that Suchman raised is that the use of the notions *configuration* and *description* have allowed the over rationalization of designers and users and the treatment of both as distinct categories. According to Suchman:

> *we need to see the designer's view of the user as at once more specific and less. More in that it is specifically located within the various sites, imaginaries, exigencies, and practices that comprise professional design and less in that artifacts*

[14] Central to Nicolini's approach to practices is the thought that agency and effect are two different aspects that a practice entails. However, for ANT human and non-human agency functions as an effect of actor-networks (Sismondo 2004).

> *are characterized by greater open-endedness and indeterminacy with respect to the question of how they might be incorporated into use. The "user" is, in other words, more vaguely figured, the object more deeply ambiguous.*
>
> (Suchman 2007, p.192-193)

The above quote has also helped this thesis to approach various groups of healthcare professionals by focusing on their *materially mediated practices*. Consider the following situation: Observations that took place at the mother-child facility and concerned the use of gloves and gowns revealed that the clinicians and non-clinicians had different ways of wearing and disposing of them. This observation led the thesis to identify more similarities and differences that concerned the use of gloves, gowns and other material. These observations were not used for analyzing each group's practices as separate. Instead, they were used for the purpose of examining when and how particular knowledge about hygiene was generated at the facility.
A complementary point of departure for approaching human actors is a focus on the various uses that artifacts can afford. This approach assumes that the empirical examination of those groups, as well as their definition as such, begins from the study of relations between social and natural objects, such as the relation between hygiene practices and gloves (see above example). Latour (2005) suggests that the appreciation of multiplicity in objects, such as artifacts, requires an appreciation of their agency:

> *We have to shift…from an impoverished repertoire of intermediaries to a highly complex and highly controversial set of mediators.*
>
> (Latour 2005, p.117)

Latour's suggestion to approach objects as mediators, leads to the next subsection. There, the methodological point of *following the things* is used as a point of departure for discussing the implications that arise when the empirical study of patient safety practices considers non-human entities as capable to act.

Following the Things

According to Marcus, multi-sited ethnography entails the empirical study of circulated artifacts, such as gifts, money and intellectual property, which constitute an initially conceived object of study. The motto *follow the thing* has sensitized the thesis towards the material manifestations of each unit of analysis that comprise this thesis' object of study, that is patient safety practices. In practical terms, the thesis had often initiated an empirical inquiry in a field site by focusing on artifacts, concepts or other entities ("things") and on the ways that informants appropriated these. The choice of which thing to follow was a complicated process but there was one question that acted as a helpful support: "What is this?" This question was posed at informants while they were using or discussing things that seemed relevant to patient safety (e.g. gowns).
The informants' answers to this question often helped with decisions on whether particular artifacts and other entities were relevant to the thesis's object of study and/or whether these could be(come) elements of the unit(s) of analysis under empirical investigation. An example of such considerations is the empirical investigation of a tinted glass that stood between a

simulation and the control room at the healthcare simulation center (SIM). A decision to include it in the inquiry allowed the thesis to foreground the relations that were developed between instructors during role-plays (see also article in appendix 1).
The following of things during fieldwork required attention toward the processes through which a particular thing (be it material, cultural, conceptual or other artifact) had been developed in the past and was currently used. The interest in the development and use of artifacts across time is related to the thesis' approach to patient safety practices through the use practices of informants (see Chapter 1, Section 1.3). The generation of data about such processes took place during interviews with informants. Some of the theoretical resources that have helped toward this direction are Latour's (1999) notion of *circulating reference* and Law's approach to the notion of *immutable mobiles* (Law 2002).[15] However, these notions have supported more the thesis's theoretical basis and less its methodological approach to patient safety practices.
Particular metaphors have helped the thesis to study patient safety practices and maintain its focus on the material manifestations entailed in such practices. For example: 1) The work of healthcare simulation instructors at SIM has been supported by the metaphor of *laboratories*. 2) The work of clinicians and non-clinicians toward young patient hygiene at the mother-child facility has been approached through the metaphor of *cleanliness and dirt.* 3) The work of various professionals at Innovation Units has been supported with the metaphor of *projects*. Below the contribution of those metaphors is briefly discussed.

The healthcare simulation center (SIM) and the metaphor of laboratories and laboratory work
During data generation, the thesis approached the healthcare simulation center (SIM) as a laboratory. Such approach was supported by the early-made empirical observation that the conduction of healthcare simulations at SIM entailed *experimental work.* Here, it is worth mentioning that experimental work has been the focus of *laboratory studies* (e.g. Latour and Woolgar 1986, and Knorr-Cetina 1999). The experimental work that took place at SIM concerned the daily work of the informants that worked at SIM as instructors.[16] Often, they drew on various artifacts and locations that resembled care delivery settings such as an Operating Room (OR) for facilitating role-plays of particular medical procedures. Participants in such role-plays were clinicians that followed formal training programs for various reasons. After observations of various role-plays it became clear that the appropriation of those artifacts and locations by instructors (and participants of role-plays) resulted into slightly different versions of the "same" medical procedures. A support to the empirical exploration of such phenomenon was a set of notions that originated from the vocabulary which has been used in the aforementioned laboratory studies. For example, Latour and Woolgar's (1986) use of the notion of *tinkering* has led the thesis to empirically examine the ways through which instructors reacted to complications that emerged while they facilitated role-plays (see article in appendix 1 and

[15] While the thesis is aware about the debate in STS, and more precisely Latour's approach, to things and objects (e.g. Latour and Weibel 2005) it wishes not to deal with it. The thesis' approach to things, objects and artifacts mainly depends on how its actors define them.

[16] Most of them had a clinical background (e.g. nursing, anesthesiology) and had been simultaneously working in healthcare settings. A few of instructors had a non-clinical background, such as social psychology. Whenever is necessary distinctions are made. But generally, the empirical study of instructors refers to them who have clinical background.

Chapter 4 - case analysis 1). This and other notions, such as those of *bricolage* (Knorr-Cetina 1981 cited in Sismondo 2010), *representation* (Latour and Woolgar 1986) and *intervention* have formed the mindset under which data generation at SIM took place. Knorr Cetina's review of laboratory studies (1995) and Binder's et al. (2011a) notion of *design laboratory* are also useful references.

Knorr-Cetina's review of the notion of laboratory (1995) has brought to the thesis' attention the notion of reconfiguration (see also Chapter 2) and it had led it to seek the usefulness of such notion in approaching SIM as a laboratory. Briefly put, part of her argument was that laboratories entail processes:

> *...that "align" the natural order with the social order by creating reconfigured, "workable" objects in relation to agents of a given time and place…[and]install "reconfigured" scientists who become "workable" (feasible) in relation to these objects.*
>
> (Knorr-Cetina 1995, p.146)

The quote's reference to workable objects as being created has inspired the exploration of how "things", such as role-plays, are developed each time that are performed. This approach has allowed the thesis to compare seemingly similar things (e.g. two role-plays of the same procedure) and to explore differences and similarities in the way that these were performed. However, the important part of the above quote is that it concerns *reconfigured scientists* inspiring a focus on how and whether *activities* at SIM configured the approach of instructors to patient safety practices (see also Chapter 4-case analysis 1, and article in appendix 1). In this way, the reconfiguration of instructors allowed the thesis to study a particular patient safety practice that spanned across healthcare and simulation settings by remaining impartial toward the non-human entities' capacity to act.

Binder's et al. (2011a) notion of *design laboratory* has also been a helpful reference for inquiring how SIM and instructors related to each other. Briefly put, design laboratories are physical environments in which design researchers apply various methods of collaborative design. In doing so, they bring together various stakeholders and involve them in the development of new artifacts and services that usually concern one of the stakeholders. Binder et al. (2011a, p.2) mention three principles that accompany their own design laboratory at the Danish Design School (KADK). The first is that a design laboratory is a *learning space* where participants try out various possibilities without many external disturbances. The second is that design laboratories entail a *collaborative envisioning* of what is to be designed and this occurs throughout temporarily distinct sessions that take place in the design laboratory. The communication of what has taken place within the laboratory to non-participants is just as important as the work which takes place *outside* the laboratory. The third is that design researchers do not just provide the methods upon which their participants collaborate but they also *participate* in the actual design of artifacts and services. They are simultaneously hosts of the design laboratory and concept designers.

The first principle has inspired an approach to SIM as a learning space in which the locations and artifacts that instructors used in their daily work (e.g. role playing facilitation) potentially allow them to generate knowledge that is not only useful for their participants but also for themselves.

The second principle has brought to the thesis's attention the processes under which instructors at SIM worked together. This included the empirical examination of the ways that instructors with various, and yet clinical-specific backgrounds related to healthcare simulation work practices.
The third principle inspired the explication of instructors' insights about the different roles that they undertook throughout their daily work at SIM. Schematically, these were: scenario designers and facilitators or scenario-based role-plays. More precisely, the focus was on when and how the boundaries of those two roles became blurred or distinct as well as on the knowledge that was required for the performance of each role.

Mother-child healthcare facility and the metaphor of dirt

Most of the data generation activities at the mother-child healthcare facility (hereafter facility) concerned the work and collaboration between clinicians and non-clinical professionals that worked at the facility (hereafter non-clinicians).[17] The thesis examined such work by following the ways that clinicians and non-clinicians ensured that *young patient hygiene* was not threatened during *play activities* at the facility (see also, Chapter 4, case analysis 2 and article in appendix 2). During early fieldwork activities at the facility, it became clear that clinicians and non-clinicians used a variety of artifacts and locations in order to identify the status of toys that young patients played with while being hospitalized. For clinicians and non-clinicians, toys could be either clean or unclean. The work of Mary Douglas with purity and danger (1966) inspired the thesis to approach the clean/unclean status of toys under the metaphor of *dirt*. Douglas mentions about dirt:

> *If we abstract pathogenicity and hygiene from our notion of dirt, we are left with the old definition of dirt as matter out of place. This is a very suggestive approach. It implies two conditions: a set of ordered relations and a contravention of that order. Dirt then, is never a unique, isolated event. Where there is dirt there is a system. Dirt is the byproduct of a systematic ordering and classification of matter, in so far as ordering involves rejecting inappropriate elements. This idea of dirt takes us straight into the field of symbolism and promises a link-up with more obviously symbolic systems of purity.*
>
> (Douglas 1966, p.36)

Douglas' approach to dirt has inspired the thesis to empirically attend to some of the tasks that clinicians and non-clinicians undertook for *ordering* and *classifying* artifacts, such as toys, for the purpose of maintaining young patient hygiene. The notion of ordering has concerned authors like Law (1992) and Mol (2002) and the notion of classification has been central to the work of Bowker and Star (1999). But how have these notions helped or inspired a particular direction for data generation and their analysis?
For example, the focus of the empirical observations was on the ways that clinicians and non-clinicians interacted with toys at different locations within the facility. While observing those informants two issues became clear:

[17] The term non-clinician and its implications are discussed in the article that can be found in appendix 2.

1) The identification of toys as clean and unclean was taking place in special locations, *the playrooms* and it was accompanied by explicit procedures and artifacts (e.g. disinfection napkins) that were introduced by the facility's hygiene department. The notion of ordering allowed the thesis to attend on how hygiene was achieved locally, within the playrooms. In addition, the notion of ordering allowed the thesis to maintain an empirical focus on the differences and similarities between playrooms.
2) While the procedures and artifacts were the same in each playroom the separation of toys into clean/unclean was done by non-clinicians and in slightly different ways in each playroom. In some playrooms artifacts that were not mentioned in the procedures of the hygiene department supporting the separation of toys. In light of the notion of classification these observations allowed an empirical focus on the artifacts and tasks through which toys were separated and stored as clean/unclean in each playroom.

Innovation Units and the metaphor of projects

A common characteristic in all the Innovation Units (IUs) that contributed to this project's data generation was their approach to patient safety through *projects*. Moreover, the generation of data on various IUs in the World Wide Web and during interviews at three IUs made clear that: 1) Projects were a common way for working among professionals who staffed IUs, such as service and product designers, IT engineers, sociologists, healthcare administrators and others. 2) Projects were the context in which the aforementioned professionals approached patient safety as a challenge that could be solved with technology-driven solutions. 3) Projects were the context in which IU professionals invited clinicians to participate as *users* in the development of new artifacts and services that were intended to improve the latter's daily challenges with the delivery of safe care. 4) The cost, status of completion and human resources that each project required were some of the qualities upon which the funding of IUs was discussed by private and public bodies. In other words, projects were ubiquitous in IUs, they served multiple purposes and related IUs to many stakeholders. Given the little amount of time for fieldwork, the empirical challenge was choosing which projects (or at least components of them) would be included in the study of IUs.
Thinking about projects as *emergent spaces with multiple ontologies* (Nocker 2006) has led the thesis to focus on the premises upon which projects about patient safety were initiated. An example of the examined premises is the use of workshops and prototypes at IUs. Within a workshop setting IU professionals approached clinicians (e.g. nurses and doctors) as experts of their own challenges and needs. The use of prototypes during the workshops allowed IU professionals to approach clinicians as users of future technologies. This perspective on projects allowed the thesis to examine patient safety practices by focusing on artifacts and vocabularies that constituted work at IUs and were used by IU staff for engaging clinicians.

(Un)following the conflict and the error

Marcus (1995, p. 110) suggests that one way for generating a *terrain of multi-sited ethnographic research* is to follow the involvement of different actors into conflicts. This approach is not foreign to STS literature. Latour (2005), for example, has been suggesting how to "feed-off" controversies in order to study how actors partake in the formation of agencies and groupings. According to Latour the examination of the processes through which groups and agencies are

formed, frees one from claiming too much about the constitution of the social world. A decision to study patient safety practices by following controversies would require another (yet particular) treatment of the metaphors *rolling the snowball* and *following the actors*. For example, the daily work of informants and their interaction with artifacts would be compared or related to the extraordinary aspects that controversies bring forth for the implicated actors. After all, conflicts and controversies about patient safety are likely to arise *after* a realization that something went wrong, has caused errors or, at least it had the potential to.

Methodologically the following of a controversy in areas that are concerned with patient safety would mean following the "error." Such route would still lead to a multi-sited empirical approach to patient safety practices but it would require a focus on the work of patient safety specialists, such as healthcare professionals (including clinicians) working for the Danish Society for Patient Safety (DSfPS). However, the questions of: 1) how is safety achieved in daily work at healthcare settings and 2) what kind of safety is produced shall summarize this thesis' *empirical approach* to patient safety practices. Of course this approach is not new, does not stand alone and has been influenced by the below-mentioned literature that falls under the category of patient safety research.

Leape, Vincent and Reason have been studying patient safety through a focus on causes of errors (e.g. Leape and Berwick 2005, Reason 2000, Vincent 2003). Central to such approach is the identification and classification of errors in different categories and the analysis of the latter as factors. The standpoint from which their line of research contributes to an understanding of patient safety practices refers to a detailed examination of errors through actions that have already taken place. In other words, such approach to safety is more concerned about the unsafe aspects of practices and how these can be eliminated.

Another group of authors, such as Holnagel, Wears, Woods and Braithwaite have proposed that the study of patient safety should focus on what works well during situations or events that have been previously deemed as critical for care delivery (e.g. Holnagel, Woods and Leveson 2007). The following quote that comes from a recent White Paper summarizes this approach:

> *the definition of [patient] safety should be changed from 'avoiding that something goes wrong' to 'ensuring that everything goes right'*
>
> (Holnagel, Wears and Braithwaite 2015, p.4)

The above quote refers to the management of patient safety and illustrates a positive approach to it, that is much closer to the thesis' question of how is safety achieved. The study of patient safety practices under a positive approach has provided empirical cases and analyses on *how* things work well (e.g. Mesman 2011, Cuvelier and Falzon 2010). Despite a common motivation about what works well such positive approach does not constitute a coherent set of patient safety studies. For example Cuvelier and Falzon (2010) have attempted to collect data about what worked well among a group of anesthesiologists in situations during which they dealt with uncertainty. In doing so, the authors used interviews and focused their efforts in collecting posteriori data about "incidents". Accounting for the challenges of such approach they mentioned:

> *It is...theoretically possible to collect events that had a particularly beneficial impact on the success of the activity. But in practice it turns out that one obtains mostly negative events. Thus, to understand the system performance in general – both failures and successes - our collection of scenarios focused exclusively on cases of near accidents where adaptations were successful.*
>
> (Cuvelier and Falzon 2010, p.32)

The above quote shows that a positive approach to patient safety may share methodological grounding with the aforementioned error-focused approach. Therefore, it may account for what has taken place in the past in terms of failure and success and to do so it draws on notions that are related to the study of errors, such as *near accidents* and *negative events.*

For empirically studying patient safety practices this thesis draws on literature that is concerned with the explication of what works well in healthcare practices and studies the latter with support from ethnographic means. Works of Mesman (2011), Iedema et al. (2013) and Jerak-Zuiderent (2012) hold some common points toward this approach and have influenced the empirical approach of the thesis concerning the relation of patient safety and work practices. The common ground that such literature shares can be understood as the motivation to explicate how patient safety is achieved and how patients remain safe while being on treatment. It does so by focusing on the mundane and routinized daily work that takes place in healthcare settings.

Mesman (2011, p. 72-73) provides a set of methodological principles of how to empirically study patient safety practices without following the errors: 1) To understand the dynamics of safety practices requires an in-situ empirical approach and ethnography is suitable for doing so. 2) A focus on processes rather than products allows the explication of seemingly self-evident actions and their potential for safe-practice. Helpful sensitizing recourses are the notions of fine-tuning and alignment. 3) An empirical focus needs to be maintained on what informants gather as ordinary, usual, regular and, therefore, almost invisible.

The above principles have influenced the approach of this thesis, but some clarifications are necessary. 1) Ethnography might be well suited for studying the dynamics through which patient safety practices are produced but those dynamics might have a broader scope than the work of clinicians. 2) A focus on processes may help the explication of self-evident actions but the latter often entail the use of various artifacts. These need to be considered, at least as points of departure. In doing so, artifacts need to be considered as actors in processes of fine-tuning and alignment. 3) To understand the role of in-situ practices in the achievement of patient safety requires a focus on the ordinary, the usual, the regular as well as the provocation of the ordinary during fieldwork.

3.3 Data generation and methods

The empirical examination of patient safety practices took place at: 1) a healthcare simulation center (SIM), 2) a mother-child healthcare facility situated within a university hospital and 3) two Innovation Units. During data generation the work of informants was studied through participant observations, interviews and workshops with participatory engagement. The analysis of the generated data was supported by the crafting of case analyses. These were supported with photographs and vignettes. The methods of participant observations, interviews, workshops with participatory engagement and case analyses are explained below.

Participant observations

Participant observations took place within SIM and the mother-child facility. The focus was on the daily work of individuals or groups of informants. In each case, observations were conducted after the permission of informants. In most cases, they were asked at least some days in advance. During observations informants interacted with people that were not initially aware that the latter were observed for the purposes of research. This was dealt as follows: 1) The informants briefly informed their co-discussants about participant observations. All concerned parties appreciated this and no further adjustments were deemed as necessary. 2) The parts of the analysis that are informed by observations have focused on the work of informants.

At SIM, the informants (instructors of healthcare simulations) were briefed that participant observations would provide insights into their learning about patient safety. Observations took place during the preparatory stages of role-playing activities, actual role-plays, meetings that followed afterwards (de-briefings) and all other activities, such as lunch-breaks. Such activities were observed during different visits at SIM. It is worth noting that, during the first day of observations at SIM, the informants facilitated role-plays for one hundred and thirty clinicians. The number of participating clinicians was unusual for the instructors but they approached the facilitation of role-plays as part of their daily work. The rest of the days concerned the training of different and significantly smaller groups of clinicians (e.g. thirty participants) with support from role-plays.

At the mother-child facility (hereafter facility) the observations concerned non-clinical professionals (hereafter non-clinicians) and focused on: 1) the ways that various non-clinicians were involved in young patient play activities and 2) how non-clinicians dealt with the hygiene of young patients. The observations took place during the working hours of groups of non-clinicians, such as pedagogues and elementary school teachers (for more details please see the methodological section in article in appendix 2) Pedagogues were observed in different locations within the facility: rooms that young patients were allowed to play, the playrooms, single and double patient rooms, kitchens and corridors. The observation of elementary school teachers also took place at various locations: an area that was mentioned by all informants as elementary school and in which the teachers had their office, isolation rooms hosting young patients in quarantine, ante-rooms between the isolation rooms and the corridors and canteen of the facility.

Throughout participant observations field notes were kept in A5-size notebooks. The intention of taking notes was not for the purpose of recording any "pure" meaning in events and interactions between informants. Instead, the intention was to generate written accounts which *reflect the perceptions, experiences and commitments of the ethnographer* (Emerson et al. 2011). At the conclusion of each day, the notes were incorporated in a running log (Sanjek 1990). This consisted of additional notes that were added afterwards, accompanied by documents and photographs which were taken during observations and after permission from the main contact persons.[18]

[18] Shooting photographs and acquiring documents was a frequent activity, always conducted after written or verbal permission by key contact persons. None of the photographs and documents show or refer to patients or data that regard the medical treatment of patients.

Interviews

Semi-structured qualitative interviews (Kvale 1996, Ten Have 2004) were also conducted with some informants from the healthcare simulation center (SIM), the mother-child facility, two Innovation Units and other organizations.[19] Seven interviews were conducted with informants that worked for SIM, seven with informants that worked for the facility and three with informants that worked at the IUs. Some of them were individual interviews and some were conducted with two informants. The duration of each interview was different, lasting from thirty minutes to four hours. All interviews were conducted at the informants' workplaces and during working hours.

Interviews were used as complementary to the observations made at SIM and the mother-child facility and as the main method for empirically approaching IUs. As concerns SIM and the facility, interviews were conducted during early, middle and late stages of the fieldwork and supported the achievement of different results. In IUs, interviews were conducted once with each informant or pair of informants.

During the early stages of fieldwork the purpose of the interviews was the mapping of situations, tasks and further informants that could potentially allow the study of patient safety practices. At middle and later stages of the fieldwork interviews were conducted with some of the observed informants. The aim for conducting them was to gain greater clarity upon participant observations that concerned artifacts, vocabularies and the ways in which informants interacted prior to their observation. Helpful resources for the preparation of these interviews were field notes, photographs and documents that were gathered during previous visits to the field site. Some of the photographs and documents were also presented to the informants during the interviews with the aim of enabling them to narrate specific events, anecdotes or short stories that could potentially illustrate their answers and the content of the interviews (Banks 2001). The use of photographs and other visual material has been previously described as Photo Elicitation Interviews (e.g. Epstein et al. 2006).

Workshop with participatory engagement

A four-hour length workshop was prepared and facilitated for 1) concluding fieldwork activities that related to the mother-child facility and 2) for generating additional data about patient safety practices. Eight practitioners that had top and middle management positions at the mother-child facility participated in the workshop. Their invitation and selection was based on their interest in the empirical study, the workshop's topic as well as in their relation to the informants. It was an explicit choice of excluding the observed and interviewed informants and of including those (mid and top management) who were initially concerned about hygiene and play (see article in appendix 2) and had not, as of yet, partaken in observations and interviews.

[19] Interviews conducted at organizations, such as the Danish Society for Patient Safety and "MedicoIndustri" (an official representative organization of medical device manufacturers in Denmark), took place during the early stages of the PhD project and mainly supported an early mapping of actors that were explicitly related to patient safety. Since these were "one-off" interviews with representatives of each organization and their content was explorative they are not taken into account within the main text. However, they have informed my understanding of patient safety practices.

During the workshop, early empirical findings about young patient hygiene were put into perspective. The findings were based on empirical material that was generated through participant observations and interviews at the facility, some weeks prior to the workshop.
The workshop took place at "DTU Skylab", a facility that is situated within the Technical University of Denmark (DTU) and where similar participatory activities take place (e.g. design research experiments). Two students from the Master's program of "Design and Innovation" contributed to the design of the workshop and the generation of material for it. One of them contributed to the facilitation of the workshop.
Throughout the workshop participants were engaged in design interventions. In doing so, participants used representations of the material that was generated during the fieldwork (e.g. photographs and stories shared by informants) for reassembling them into concepts (Kjærsgaard 2013) of clinician/non-clinician patient safety practices. Throughout the interventions (see the 4 steps below), additional data were generated which concerned the approach of participants to the work practices of non-clinicians when dealing with young patient hygiene. The design interventions had the form of scenarios (Buur et al. 2004) during which the participants were: 1) separated in four groups, 2) invited to read one-page long stories which illustrated contemplations, paradoxes and daily challenges of non-clinicians' that were involved in young patients hygiene and play activities, 3) asked to use artifacts that referred to the hygiene and play activities at the facility for generating A2-size posters that described the one-page stories and finally, 4) asked to verbally present their understanding of the challenges entailed in the stories to the rest of the groups and discuss altogether how these could be dealt with.

Case analyses with the support of vignettes and photographs
The form of case analysis was chosen since the early stages of the PhD project for analyzing patient safety practices in light of empirical findings and the notion of patient safety assemblages. The crafting of a distinct case analysis for each of the aforementioned case organizations allowed the thesis to arrange the generated data under particular sub topics and to support their analytical discussion *with parts of* the thesis' theoretical vocabulary (see Chapter 2). The choice of topics and their theoretical vocabularies was an iterative process that took place throughout the PhD project. Different occasions allowed the generation and consideration of topics and theoretical perspectives, such as: a) the reporting of early data-supported findings to informants and co-supervisors (e.g. through workshops), b) preliminary analyses of data in light of conference presentations, c) the writing of fieldwork-informed assignments for various PhD-level academic courses and d) the writing of articles (appendices 1 and 2).
Ultimately, this iterative process allowed an approach of the generated data as *variables of interest* (Yin 2013, p.119). According to such approach, the generation of data did not stop at the field sites but it continued during iterative attempts of theorizing upon particular topics that emerged during fieldwork. This allowed for a theoretically informed data analysis. The crafting of each case analysis entailed the writing of vignettes of about two hundred words that were occasionally accompanied by photographs and quotes from informants. Vignettes were mainly approached as:

> *a method that can elicit perceptions, opinions, beliefs and attitudes from responses or comments to stories depicting scenarios and situations.*
>
> (Barter and Renold, 1999)

The intentions of using vignettes were two: 1) To depict situations that took place during fieldwork for the purpose of supporting, in an illustrative manner, the detailed analysis of a situation that usually followed after the vignette. 2) To allow those who would read the vignettes to reflect on their perceptions upon similar situations to those described in the vignettes.
Such method was also used during the writing of both articles that support the thesis.[20] Most notably, the method of vignettes allowed the multiple examination of situations. For example, the vignettes that supported the article in appendix 1 are approached again in Chapter 4 (case analysis 1) where they are re-examined in a different analytical context.
The photographs that occasionally accompany the vignettes fulfill a double role. On the one hand, a photograph shall allow multiple interpretations that each of them is unique for a single spectator/reader. On the other hand, the vignette's text shall provide the margins within which the photograph should be considered as a poetic visual aid and not as "evidence", "fact" or "truth".

[20] All vignettes that are presented in the thesis and the articles are written by this thesis' author.

4. Case Analyses

4.1 Overview of the chapter

This is the main analytical chapter of the thesis and comprises of three empirically informed case analyses. Each case has its empirical basis on a particular case organization (see below and Chapter 1, Section 1.6) and provides an analysis of assemblages where patient safety appears as a concern among healthcare professionals. Before proceeding further it is worth briefly mentioning the general subject of each case analysis and the sequence that these appear.

Case analysis 1 deals with the work of clinicians at the healthcare simulation center "SIM" and focuses on their efforts to develop and use scenarios that describe critical events (which could take place in healthcare settings, such as operation rooms). Case analysis 2 deals with particular categories of non-clinicians (e.g. pedagogues and elementary school teachers) that work at the mother-child healthcare facility and focuses on their involvement to hygiene practices. Case analysis 3 deals with the collaboration of clinicians and design professionals toward the development of new devices and services that hold expectations for safer care delivery.

Except the transitions from clinicians to non-clinicians and then to clinicians/non-clinicians it is also worth noting that the first two case analyses bear on fieldwork that lasted longer while the third one is supported by limited empirical material that was mainly generated through interviews.

As mentioned in theory chapter (Chapter 2, Section 2.1), assemblages constitute an overarching and underlying notion for all three case analyses. It is worth clarifying that assemblages are employed in all case analyses as *points of departure* for analyzing how patient safety figures as a concern in the daily work of healthcare professionals. In other words, assemblages are *the phenomena that* need to be explained through an empirically informed analysis.

The additional notions of reconfiguration, transformation, and the set of object-oriented notions (see Chapter 2, Sections 2.2 and 2.3) are employed as elements of a theoretically-informed vocabulary that support the analysis of assemblages. However, the use of those notions in each case analysis differs with some of them being used more often in one case analysis and less in others. This is not a matter of eclecticism but an attempt to *follow the actors* (see introduction of Chapter 3, Section 3.2) while attending to the emergence of their potentially *multiple and inter-subjective truths* (Schwartz-Shea and Yanow 2012, p.5). A brief description of each case analysis is offered below.

Case analysis 1

Case analysis 1 explores how critical events that take place in care delivery settings (e.g. hospital wards) become elements of scenarios that support the performance of healthcare simulations. The analysis draws on empirical material that concern the work of healthcare professionals at a healthcare simulation center (SIM) that is situated in a Danish university hospital. It focuses on the development of scenarios during *scenario design workshops* and during the facilitation of *role-plays* – that is a particular form of healthcare simulation.

The empirical backdrop of the case analysis is additionally – yet partially – informed by data that are used in a single authored article (Balatsas-Lekkas, submitted). This can be found in appendix 1. The article draws on empirical material from SIM and presents a case of collaborative design in "the wild" - where the focus is on the continuous development of scenarios in use contexts. However, the article does not explicitly address the relation between healthcare simulation and patient safety practices. The case that is presented in the thesis takes stock of the continuous

development of scenarios but it has a wider scope: It brings into purview more occasions, spaces and actors involved in such continuous development *and* foregrounds how such actors relate to patient safety through healthcare simulation.
It is suggested that the article's sections 4 and 6 should be read together with the case analysis. Section 4 provides background information and demographics about SIM while section 6 provides a detailed empirical account of the scenario design workshops and role-playing activities.

Case analysis 2
Case analysis 2 explores hygiene practices by departing from the work of non-clinicians (e.g. pedagogues and elementary school teachers) within healthcare settings. The analysis draws on empirical material that concern non-clinical healthcare professionals' work at a mother-child facility that is situated within a Danish university hospital.[21] It examines some of the hygiene practices that relate with play and teaching activities that young patients attend at the facility's premises. The analysis attends to the ways that non-clinical professionals are involved in hygiene processes (e.g. cleaning of toys) and examined how hygiene is maintained at locations such as playrooms and isolated patient rooms.
The empirical and analytical backdrop of the case analysis is additionally supported by particular parts of a co-authored article (Balatsas-Lekkas and Mesman, drafted) that can be found in appendix 2. The article draws on empirical material that was generated at the mother-child healthcare facility and concern young patients' hygiene. The argument of the article is that healthcare professionals with non-clinical background (hereafter non-clinicians) and their practices need to be taken into account by research on patient safety practices. The case analysis that is presented in the thesis takes the involvement of non-clinicians into patient safety work as point of departure and explicates how formal hygiene systems are appropriated and developed during daily work at the facility. In doing so, the case analysis presents additional empirical material.
It is suggested that the drafted article's sections 3, 4 and 5 should be read *prior* to the case analysis. Sections 3 and 4 provide background information about the mother child facility as well as the article's main analytical approach. Then, section 5 provides an empirically informed analysis which concerns the maintenance of hygiene within playrooms and isolated patient rooms.

Case analysis 3
Case analysis 3 explores the development of devices and services by designers and healthcare professionals in healthcare settings. Having the establishment and work of small organizational departments within Danish hospitals, the so called Innovation Units, the case attends to the ways that the work of professional designers relates to patient safety practices. The focus of the analysis is on the development of Innovation Units, the initiation of projects toward the development of medical devices and on facilitation of workshops by designers – where clinicians are invited as participants.

[21] The university hospital that hosted the mother-child facility is different than the one that hosted SIM.

Finally, after all three case analyses, a brief summary of them is presented. The summary takes a brief stock of the collaborative modes under which the examined actors relate to patient safety practices. The summary sets the stage for the discussion that follows in Chapter 5.

Case Analysis 1: Scenario development in healthcare simulation

Introduction and structure

This case analysis concerns some of the processes that render scenario development in healthcare simulation as an assemblage that relates to patient safety. It approaches such assemblage by exploring how *critical events* that take place in care delivery settings become elements in scenarios that support the performance of a particular kind of healthcare simulation, the *role-play*. In doing so, it focuses on the ways that healthcare professionals[22] working for healthcare simulation, *the instructors*, use a script-form as the basis for designing new scenarios and for facilitating role-plays (that are supported by completed script-forms). The analysis is supported by empirical material generated during fieldwork at a healthcare simulation center (hereafter SIM) that is situated at a Danish university hospital (see also Chapter 1, Section 1.6) and a single authored article that was submitted for a special issue at the Journal of Computer Supported Cooperative Work (hereafter CSCW article) with a theme about "Infrastructuring and Collaborative Design" (appendix 1).[23]

The structure of the case analysis is the following: Firstly, the motivation for approaching patient safety through healthcare simulation is noted. Secondly, an extended summary of the CSCW (submitted) article is offered and is accompanied with an additional analysis that focuses on the ways that critical events are reconfigured throughout *scenario design* and *role-playing activities* (for a further and detailed definition of those please refer to the CSCW article, section 6).[24] Finally, scenario development is examined throughout a set of activities that fall outside of the explicit activities of scenario design and role-playing: The first concerns lunch breaks and corridors and the second concerns the appropriation of SIM's facilities by medicine students for self-training purposes.

1. Motivation

Why bother to focus on healthcare simulation in order to understand how a patient safety assemblage is constituted? In order to answer the question it is worth first mentioning the origins of the relation between healthcare simulation and patient safety. These can be traced in the Institute of Medicine's report *To err is human* (IOM 2000) where healthcare simulation was suggested to be a tool for safety (p. 79) and its use as a tool was related to the training of healthcare professionals on interdisciplinary work and the management of teamwork (p. 157). Moreover, since 2000 research that has an empirical focus on healthcare simulation settings and explore its relation to patient safety is on the rise (Gaba 2007). The quote that follows below (which belongs to the PhD thesis of a healthcare simulation scholar and practitioner) summarizes some of the reasons that healthcare professionals (mostly clinicians) decide to professionally relate with the field of healthcare simulation and how, in turn, such interest relates to patient safety:

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22 These were mostly clinicians, more particularly nurses and others with educational background and professional experience in anesthesiology.

23 It is suggested that the CSCW article's sections 4 and 6 are read prior to or simultaneously with the analysis that follows below. These sections of the article ought to provide a better overview of scenario design, role-plays, the script-form and the healthcare professionals (mostly clinicians) who work for SIM (the instructors).

24 The CSCW article did not have a focus on patient safety. In the article, patient safety was used as a point of departure for examining the relations of healthcare professionals' work as a case of collaborative design in the "wild". While this particular relation will be discussed in Chapter 5 the case analysis here focuses on the explication of healthcare professionals' work without drawing direct links to design.

> *Healthcare professionals are the second victims of errors after patients…Simulation settings provide unique opportunities for healthcare professionals, as they introduce a relatively safe environment in which to discuss problems and errors. Participants come together with colleagues who are familiar with the same challenges and have similar doubts and experiences. The simulation setting allows them to talk freely about errors, away from the restrains of patients and relatives*.
>
> (Dieckmann 2009, p.44)

The approaches of healthcare simulation as a tool and as a safe environment have intrigued this thesis. This is because early ANT studies (e.g. Callon 1991) have shown that "tools" entail consequences for those who develop them and for those who use them. Some STS-informed studies of healthcare simulations have taken into account some of those consequences. Prentice (2005) has examined the interdisciplinary design of a surgical simulator and analyzed it as a virtual patient that helped the training of surgeons in surgery processes. Johnson (2007) has empirically approached the simulation-based training of medicine students and studied the sociomaterial premises under which healthcare simulation becomes a context for participating students. The work of both authors has pointed toward some of the effects that healthcare simulation settings have generated for the healthcare professionals. However, the transformation of particular elements that allow patient safety to become the "ground" for healthcare simulation has not been explored. This case analysis attempts to describe the premises under which critical events that have been taking place in care delivery settings become transformed into elements that support a particular kind of healthcare simulation: the role-plays. The interest in such transformation concerns the effects that it potentially generates for the healthcare professionals (mostly clinicians) who participate in the development of scenarios and the facilitation of role-plays.

2. Extended summary of CSCW article

The article *Infrastructuring in healthcare simulation: A case of collaborative design in the 'wild'* (Balatsas-Lekkas submitted) was written as a response to JCSCW's call for papers about "infrastructuring and collaborative design". The empirical scope of the article was the development of scenarios during *scenario design* and *role-playing activities* at the healthcare simulation center "SIM". The focus of the article was on the work practices of instructors. The main argument of the article was that instructor participation to scenario development is a contested matter, it's shaping is temporary, continuous and, entails multiple work practices. These were described as *infrastructuring practices*. The temporal and multiple aspects of instructor participation in scenario development were examined with support from the notion of reconfiguration (Suchman 2007).

Infrastructuring and infrastructuring practices

The article approached scenario design and role-plays as elements of SIM's information infrastructure following the empirical observation that scenarios were central elements in instructors' daily work. The notion of *infrastructuring practice* allowed the examination of some sociomaterial processes through which scenarios were developed at SIM. In doing so the analysis of scenario development departed from the interaction of instructors with a particular artifact, the *script-form*.

The analysis of scenario development focused on the formal processes of *scenario design* and *role-playing*. The main finding was that the development of scenarios begun in formal processes (e.g. workshops for scenario design) *and* continued throughout role-playing activities. Each time that a (seemingly complete) script-form was used as the basis for a role-play, the scenario that was described in the script's categories was reconfigured. The nature and scope of each reconfiguration depended on the uncertainties that emerged through the performance of scenarios by instructors and participants. The examination of some uncertainties took place by:
1) Investigating a particular scenario design process in which instructors participated as scenario designers and developed new scenarios about "non-acute yet critical events". The instructors attended to the performance of the new scenarios during role-plays by considering the staging and clarity of a non-acute yet critical event and their own future role as facilitators (of role-plays).
2) Exploring various role-playing activities in which instructors participated as facilitators. Throughout the role-plays pairs of instructors had to: a) adjust their facilitation work and strategies according to their participants' engagement with particular aspects of the scenario and b) align the expectations that they had from each other.
Both parts of such analysis supported the article's argument that scenario development continues in role plays and its continuity is achieved because instructors get to participate in such development through various sociomaterial practices and by undertaking different roles (e.g. scenario designers and facilitators). The notion of reconfiguration supported the article's discussion of instructor work practices as a case of collaborative design processes that take place in settings that professional designers do not participate in direct ways .
The following analysis concerns the use of script-forms by instructors. Here, the focus is placed on the processes through which critical events concern instructors during scenario design and role-playing. The notion of reconfiguration has inspired the accounting of the effects that are generated while critical events become elements of healthcare simulation. While the examination of those effects could have been done in many ways this and the rest of the sections draw and elaborates on the themes that concern the filling up of script-forms, role-playing facilitation and life-saver development and use.

Filling up script-forms
The following excerpt is taken from a scenario design workshop and concerns a discussion between two instructors. While attempting to fill up the scrip-form category narrative description with a non-acute yet critical event the two instructors mentioned:

> **Instructor A**: Imagine that the setting is…I have some bread over there…and the nurse has to learn how to make it into little pieces and give it to the patient to eat…and the patient is: Aghhhagharrrahg…(sounds of choking).
>
> **Instructor B**: Ok, that's a non-acute situation..?
> **Instructor A**: But that's the discussion now...what is the situation?

The above excerpt illustrates one situation where the use of script-forms allowed instructors to consider a particular activity that could have taken place in a care delivery setting (e.g. feeding a patient) while attempting to clarify how it could be introduced in the script-form as an non-acute yet critical event. For example, at the beginning of the discussion, Instructor A

refers to a situation (or event)[25], that *could* have taken place in a care delivery setting. However, the rest of the dialogue shifted toward the definition or clarification of such an event/situation as a non-acute yet critical one. Similar and lengthier discussions and clarifications that spanned across care delivery and healthcare simulation took place during the scenario design workshops. The topics of these discussions were determined by the script-form categories and regarded issues such as: 1) the use of mannequins and/or standardized patients[26] during role-plays, 2) the clarification of the "patient's" vital signs (e.g. heartbeats and pulses), 3) the settings in which the situation/event was taking place (e.g. postoperative facility), 4) the use of artifacts as "props" and, 5) the definition of the groups of participants (e.g. experienced and/or novice nurses).

The filling up of the script-forms engaged instructors in a problematization process (Callon 1986) during which they defined the elements and the processes that would constitute a *simulated* critical event. But where did the critical aspect lie in the non-acute events that instructors discussed? The following excerpt that is chosen from an audio recording of a scenario-design workshop illustrates this. After the agreement of the team members that their scenario would be about postoperative treatment of an elder patient with support from a standardized patient, two group members discuss the main idea of the scenario:

> **Instructor A:** So you can tell that the [standardized] patient is in bed, that he has wounds, that it's his second day after surgery and didn't want to get up from his bed yesterday and today the nurses come to try again to get him up. Their goal would be to convince the patient to take a few steps, sit at the table for that time – because normally he sits beside. So it's realistic that the nurses [will try to] increase the amount of [the patient's] steps or [make him] just stand up, to turn and sit down. That might be enough.
>
> **Instructor B:** But how can we tell to the standardized patient when to be convinced?
>
> **Instructor C:** We can give him an earphone.

In the above-described situation the critical element stands in-between the patient's well being and the potential acquisition of bedsores. What makes the issue stand in-between those two aspects is instructor A's focus on *convincing* the patient rather on the actual work and errors that may occur while supporting a patient to get up from his/her bed (for such case see Iedema et al. 2010). Interestingly, a discussion about potential *errors* throughout the movement of the patient was absent during the workshop.[27] In this way, the critical aspect of the above-described event regarded the communication of the (standardized) patient with the nurse(s) and the prevention of the patient's condition to develop in a particular way, whereby lying on the bed for long time would result into bedsores.

Thus, the engagement of instructors with the script-form and its categories enabled the transformation of a phenomenon, such as a patient's limited mobilization (not in ANT terms),

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[25] In the quote, instructors referred to situations instead of events but further observations revealed that they used both terms without drawing distinctions between them.

[26] Mannequins are special devices developed for healthcare simulation and resemble some of the human body's conditions, such as color, temperature and voice. Standardized patients are humans who work for healthcare simulation centers or facilities and take the role of the patients in various scenarios.

[27] However, it is assumed that these could have been discussed during the debriefing stage.

into a set of particular relations between artifacts and humans. These relations regarded the use practices of participants, instructors and standardized patients during a role-play. However, the definition of their content required the instructors to draw on their individual experiences with care-delivery work.[28]

Participating in scenario design workshops

Some elements in the aforementioned transformation were pre-given, such as the categories of the script and the length of a scenario design workshop. It would be fair to mention that instructors *participated* in the scenario design (and in the problematization process entailed in it). Throughout those workshops each instructor had the possibility to stress, for the rest of the group members, particular elements that (s)he had previously deemed as critical (e.g. vital signs) while allowing others to share their perspectives about them as well as to bring up their own experiences. This became empirically evident throughout the micro-negotiations that accompanied the filling up of each category that was part of the script-form but also *after* the end of the workshop. The transcribed dialogues of all four workshops revealed that, while instructors filled up one category after another, they also reiterated their definition of the critical event that supported their scenario. Those micro-negotiations and the iterations allowed instructors to consider the ontologies (Mol 2002) that a critical event *has* in care delivery settings while defining it as a central element for their scenario. Here, ontologies refer to each instructor's experience(s) with situations or events that were similar with the one under design and had taken place in the workplace that each instructor worked in.[29] The explication of such considerations contributed, to some extent, to the generation of a critical event that represented the instructors' experiences and its form was suitable for simulation. Of course, the consideration of such ontologies was delimited: The script categories were pre-given and the definition of the use practices that corresponded to each category required from instructors to decide which elements would be included and which would be excluded from the script. An example of such inclusion and exclusion may refer to the condition of the "patient" that is described in the script-form. All instructor-groups that participated in the scenario design workshops created scenarios that were based on standardized patients and not on mannequins. As hinted above, the main reason for such common choice was that non-acute events entailed verbal communication challenges between clinicians and patients. Instructors tackled the transfer of such challenges to healthcare simulation settings as a problem of inter-personal communication. The consequence of such choice was that further instruction needed to be given to whoever would play out the standardized patient. However, the definition of the content of such instructions proved to be difficult (see last excerpt of previous subsection). Most groups implicitly chose to leave it open and did not discuss it thoroughly, even though they could have done so while filling up different categories, such as those of *simulator setup*, or *simulator operation during scenario*. The difficulty of instructors to fully anticipate the reactions of their (future) participants and the limited time of the workshop may hint to some of the reasons.

Therefore, the participation of instructors at the workshop did not only lead to the design of a new scenario but also allowed a consideration of *what are* critical events and some of the potential uncertainties entailed in them. It could be mentioned that instructors became aware

[28] As mentioned in Chapter 3 and in the CSCW article, most instructors have a medical professional background.

[29] As mentioned in the CSCW the instructors who participated in the scenario design workshop were working at different hospitals as nurses.

of different approaches to critical events and in this way the scenario design contributed to a collective way of learning about the critical event that they attempted to define for the purpose of the scenario design. Such learning took place while instructors drew simultaneously and interchangeably on their experiences with care delivery and healthcare simulation. Therefore, it would be fair to characterize instructor participation in scenario design as a form of a *collaborative knowledge practice* (Ewenstein and Whyte 2009) where knowledge refers to past experiences but also to the generation of awareness during the scenario design.

The role of script-forms in the materializing of critical events

It is also worth examining the scrip-form and the role it played in the engagement of instructors with the material properties of the critical events during the design of scenarios. In doing so, it is also worth approaching scenario design workshop as a sociomaterial entity that could be understood as *a collective space in which people come into contact with the materiality of an artifact and produce various functions* (Leonardi et al. 2012, p.4). The artifact that is mentioned above is the script form and the various functions are the use practices that it affords. The process through which such functions are generated has been previously mentioned as problematization but it can also be approached as *framing* (Callon 1999) or as a bracketing of relations that each use-practice entails. Such bracketing entails the definitions of a particular matter, such as a critical event, through its entanglement with some particular sociomaterial relations as well as its disentanglement from others.

Then, on the one hand, the engagement of instructors with the script-form and the settings in which the scenario design took place (e.g. meeting rooms at SIM) contributed to the *disentanglement* of critical events from (material) properties that had previously constituted them in various care delivery settings. On the other hand the engagement of instructors with the script-form and its categories *entangled* critical events with particular material properties that concerned healthcare simulation settings.

An example that applies to all groups that participated in scenario design workshop concerns the commonalities of the setting that each group's patient would be treated. All groups referred to post-operative situations or similar forms of recovery from illness but not in pre-operative care. This decision entangled the definition of non-acute yet critical events with particular settings such as patient rooms, particular parts of therapies and artifacts, such as the insertion of intravenous lines to patients and so on. Central to these decisions was instructors' consideration of the settings that the scrip-form *would be used*. In doing so they often considered SIM's available simulation rooms and technologies.

Another example that illustrates the disentanglement move concerns the groups' considerations to get support from standardized patients for scenarios that regarded inter-personal communication. Even though the scenarios described a rather stable situation for the patient some groups spent considerable time to negotiate the values that had to be inserted in the script-form's category entitled as vital signs (e.g. pulses, temperature, color). Such values were expected to remain stable throughout the role-play of the scenario.[30]

This perhaps came at the expense of not discussing thoroughly the instructions for the standardized patient. Then, during scenario design the definition of non-acute yet critical events was disentangled from vital signs. However, due to script-form's category of vital

[30] In an alternative case where the scenarios would be supported by a mannequin the vital signs could be changed throughout the role-play by the operator.

signs (which had supported, in the past, the design of scenarios about acute critical events) such disentanglement took place at the expense of spending time on excluding vital signs.
In light of Callon's suggestion that framing is always *incomplete* the aforementioned challenge could be understood as part of the *experimental* aspects that scenario design entails. An attempt to scope, or to define the boundaries, of such incompleteness is the introduction of a particular category, the *scenario life-savers* (hereafter life-savers) into the script-forms that support scenario design. These have been briefly discussed in the CSCW article (Balatsas-Lekkas, submitted). The following subsection re-examines the filling up of such categories in light of critical events' incompleteness.

Designing scenarios with support from life-savers
Life-savers appear in each script as a distinct category and have been approached as plans and interventions by research on scenario design for healthcare simulation (e.g. Dieckmann et al. 2010). From such perspective the notion of plan refers to their filling up during scenario design and the notion of intervention applies to their use during role-plays. This subsection focuses on the role of life-savers as plans. An example of what it is written under the category of life-savers can be found in the CSCW article. Accounting for the filling up of life-savers during scenario design Dieckmann and collaborators (2010) mention:

> *During the design of scenarios, the simulation team should try to anticipate where participants [in role-plays] are more likely to do something unexpected, such as when they have more than one option for action. The application of principles of failure modes and effects analysis might be helpful when working through the scenario. This means that the simulation team works mentally through the scenario, trying to identify where participants could do something unexpected, how an unexpected action would be recognized, and how the simulation team could react in such a case.*
>
> (Dieckmann et al. 2010, p. 221)

The simulation team's (or instructors') consideration of their participants' *options for more than one action* as well as the *unexpected actions,* requires prior experience with the facilitation of role-plays but also knowledge on the scope and nature of the critical event that is described in the scenario. In the life-saver scenario that is described in the CSCW article the status of the patient's asthma condition depends on the assessment of the instructors regarding their participants' actions towards the treatment of the *mannequin as patient*. However, the assessment of instructors about such actions can only be done with the support of their personal and collective medical-specific knowledge. This is a very delicate point for the design of scenarios because the latter defines, to some extent, the approach of instructors to the critical event that will be performed during a role-play.
According to the examples that Dieckmann et al. provide (p. 220-221) the content of scenario life-savers should lead instructors during role-plays to either 1) follow the unexpected actions of their participants and *modify* the event that the scenario and role-play were about (e.g. a case of anaphylaxis can be transformed into a case of hemorrhage) or 2) correct the unexpected actions by guiding some of the participants to act in specific ways.
Both cases do not just indicate the margins that participants can act upon during role-plays but also the scope of critical events that scenarios describe. Therefore the filling up of the category entitled as life-savers contributes to the definition of the scenario but it also leads to the consideration of the scope that critical events may acquire in care delivery settings.

Co-facilitating role-plays

As mentioned above, one of the main findings in the CSCW article was that scenarios continue to be developed during role-plays and that the performance of each role-play results into slightly different scenarios of a critical event.[31] The continuation of scenario development was illustrated through two vignettes (CSCW article, Section 6.3): 1) the first focused on the attempts of two instructors to adjust their facilitation actions according to their participants' performance *during* a role-play (of an acute critical event) and 2) the second focused on another pair of instructors and illustrated their in-between negotiation and alignment that took place while they co-facilitated a role-play. The above made clear that instructors' facilitation efforts *follow* the progress or the unfolding of a role-play and that the latter is performed by instructors and participants together. Here it is worth mentioning Dieckmann's approach to the relations between instructors and participants as a matter of "contract". Borrowing Umberto Eco's expression of *fiction contract* Dieckmann (2009) mentions:

> *The contract contains rights and liabilities for both parties (instructors and participants) that must be met by those involved or the other party may end the agreement. Whether participants are willing to contribute in this way to the success of a simulation depends on the simulation setting and the interaction of the people involved. However, [fiction contracts] for simulation settings are less reliably shared by those who engage with the simulation setting. Many of the rules of working within a simulation setting are not clear to the participants and, at times, to the instructors.*
>
> (Dieckmann 2009, p.73)

In light of participants' and instructors' performance of role-plays, a particular aspect of the above quote is interesting: the success of a simulation, including role-play, depends on the simulation setting (control and simulation rooms). The rules of working within a simulation are, however, occasionally unclear for instructors. What stands in-between (or even facilitates) the instructors' work at the simulation setting is the scenario and its material instantiation, the completed script-form. A complementary reading of the vignettes in the CSCW article (subection 6.3) suggests that the anticipation, negation and alignment of instructors took place upon matters that were described within the script-forms that they used for facilitating their role-plays. In the first vignette this is illustrated with considerations about the programming of the mannequin and in the second this is illustrated with the status of the simulator/mannequin being described as either dead or alive. Therefore, the staging of a critical event during a role-play with the support of a complete script-form entails uncertainties, which, in turn, shape the critical event as a *fluid* entity (De Laet and Mol 2000). Taking into account such fluidity two questions arise: How is a critical event performed? What are the consequences of such performance for instructor engagement with critical events during role-plays?

[31] It is worth mentioning that the empirical material that supported the analysis of role-plays refer to discussions that took place during the design of non-acute yet critical events but also to observations of performances that were supported by scenarios of acute and critical events.

1) During scenario design the scrip-form was the main object that mediated the problematization of critical events. However, during role-plays the relation between instructors and critical events entails more and complex mediations. Briefly put, instructors engage with critical events through a) artifacts, locations and concepts that constitute the simulation setting, such as the control and simulation rooms, the tinted glass that stands between those rooms, the mannequin, the "patient's" vital signs, the ABCDE approach and so on. The number of entities is almost endless but what is important for understanding the fluidity of the critical event is the *premises* under which instructors appropriate the above-mentioned artifacts. While many of the aforementioned entities are noted within a completed script-form, the degree that their relations with instructors are defined is different in each space. For example, the work of instructors in the control room can be traced while reading detailed instructions about the function of the mannequin and how its vital signs shall change during the role-play. Then, even though note taking is an activity that most instructors at SIM did while observing a role-play from the control room and used it during debriefings (see also below), instructions for such activity are not to be found in a script-form. What the above example shows is that the performance of critical events entails the transformation of the content in each of the script-form's categories. This transformation results during the use of particular artifacts. The enmeshment of instructors with a variety of new artifacts and concepts does not necessarily result in the fluidity of a critical event - unless the interaction between instructors is somewhat problematic, as in the second vignette (CSCW article, subsection 6.3). Then the fluidity of the role-played critical event concerns the (challenges for the) in-between alignment of instructors in light of their use practices and the script-form's categories. In such case the script-form could be understood as a boundary object (Star and Griesemer 1989) that allows instructors to share and negotiate their perspectives about particular elements and topics that contribute to the simultaneous unfolding of the critical event. The harsher the negotiation(s) over the use of particular elements the more uncertain the critical event becomes during the role-lay. The negotiations between instructors that take place in the background constitute the critical event as a flexible, adaptable and responsive object (de Laet and Mol 2000).

However the fluidity of the critical event is not only shaped through such negotiations but also through the performance of relations between instructors and participants. This becomes clearer by empirically focusing on *the ways* that artifacts, locations and concepts constitute the simulation setting. The first vignette (CSCW article, subsection 6.3) illustrates this point through the example of the simulator's (or mannequin's) breathing. In such situation, participants interacted with the simulator through medical-oriented activities and the result of such interactions resulted in: a) a particular function of the simulator (it stopped "breathing") and b) the instructors attempting to understand and act upon a set of relations that fell outside the scope of their up-to-then facilitation activities. In this way the performance of an element that is clearly described in each script-form's category entitled "vital signs" *becomes performed* during role-plays. Such performance does not just encompass different perspectives but also different use practices whose content is to be defined as they unfold. In such case, each of the elements that is included in the scrip-form and entails some kind of material instantiation becomes an object which, according to the Greek meaning of the word (αντικείμενο), is an entity that has a relative distance from those whom it concerns. For example, prior to the simulator's non-breathing, the instructors dealt with its functions in a manner appropriate for a *technical object* (Ewenstein and Whyte 2009) which embodied their assumptions about the course of the role-play and the unfolding of the critical event. After the simulator's non-breathing, its functions took on those of an *epistemic object* in the eyes of the

instructors (Ewenstein and Whyte 2009, Knorr-Cetina 2001) where its nature was incomplete, unfolding and partially unpredictable. While this was a temporal analysis of the simulator's breathing, it is worth briefly considering its spatial aspects too. So, while the simulator was breathing, the participants engaged with it as an *intermediary object* (Boujut and Blanco 2003) that indicated the simulator's condition and allowed them to focus on the steps of the particular intervention that they had to complete. As soon as the simulator's breathing stopped and the participants became aware of it, they had to reconsider their collective relation with it as well as their actions toward/work with it. It, therefore, became a *boundary object* (Star and Griesemer 1989). Throughout such transformations, the meaning of breathing is different for instructors and participants. For instructors it represents further work with (and decisions about) the staging of the critical event and for participants it portends further work toward the resuscitation of the simulator's berating. The work of each group is mediated with the use of different artifacts that indicate the simulator's breathing. Instructors engage with it through the console and the software program that controls the simulator's function. Participants engage with the simulator through the materials that indicate the simulator's breathing, such as the monitor that displays the vital signs, and through the materials that enable them to intervene.
Therefore, the performance of the critical event during role-plays implicated instructors and participants into sociomaterial relations that were defined by the transformative capacities of objects.

2) Based on the above analysis some things can be mentioned about the engagement of instructors with critical events during role-plays. Before doing so, it is worth reminding that during the scenario-design, instructors problematized critical events under the sociomaterial premises of scenario design, such as the categories that had to be filled up, the time-frame of the workshop and its location. Thus, during scenario design instructors problematized critical events while also developing a form of a *collaborative knowledge practice*. During role-plays such practice continued but it also became partially transformed. This is because it entailed additional negotiations in-between instructors as well as their anticipation and alignment *in light of* their participants' interactions with the simulation setting and the script-form. Such practice brings about the reframing of the critical events during role-plays and relates instructors with it through a set of uncertainties that accompany each role-play, and therefore their collaborative practice. While the above analysis rendered these (different) uncertainties as mainly practical matters that allow the (smooth) continuation of role-plays they can also be thought of as indications toward a context in which instructors engage with the *scope* of critical events. These practices do not just concern the act of filling the categories of a script-form. For example, the in-situ re-programming of the simulator's breathing does not only require from instructors to draw on knowledge about the values that will keep the simulator "alive" during the role-play. It also requires knowledge about the potential ways that the critical event will unfold further and whether/to what extent such unfolding will respond to potential situations taking place in care delivery settings. Considering that each role-play can potentially generate a slightly different performance of a critical event, it may be worth seeing role-plays as additional spaces in which instructors engage with critical events and potentially learn about their scope. Thus the collaborative knowledge practice of instructors is also a process of learning. Role-plays render a space where such learning takes place. This is mediated through artifacts that have multiple roles. One of them is the scrip-form: 1) Its content may create uncertainties to the facilitation efforts of instructors (Ewenstein and Whyte 2009). 2) The fulfillment of its objectives (e.g. learning goals) requires from

instructors to participate in role-plays rather than to facilitate them (Henderson 1999). 3) It mediates the course of role-plays by enabling the in-situ representation of critical event, where such representation is different for instructors and for role-play participants (Boujut and Blanco 2003). 4) It enables instructors to interact and complete the facilitation of role-plays while it allows them to maintain some of their individual perspectives (Star and Griesemer 1989).

While the aforementioned uncertainties have been rendered as emergent and as consequences of the role-plays' unfolding course, some of the material aspects that accompany them should be taken into account. For doing so it is worth considering how life-savers are performed during a role-play.

Performing life-savers

The empirical material that is presented in the CSCW article (subsection 6.4) provides an example on the content of the life-saver category as well as on the window that stands between the control and the simulation room. The window could be thought of as a permanent material instantiation of life-savers within SIM facilities. Then, the window represents the instructors' knowing about uncertainties that may occur during role-plays and it enables instructors to deal with them in a particular way, making use of communication and further engagement with artifacts. The window enables communication a) between instructors – given the fact that one instructor may observe the role-play from within the simulation room and (s)he may need to exchange information or observations *during the role-play* with the instructor and the operator that are situated in the control room and b) between instructors and participants. The latter communication may take place when the control room's instructors need to share information with or to further instruct participants (e.g. in order to get them back on track). In a situation where a life-saver is necessary during a role-play, then both forms of communication are further mediated by artifacts that are developed for supporting the performance of the life-savers. Figure 1 presents those artifacts.

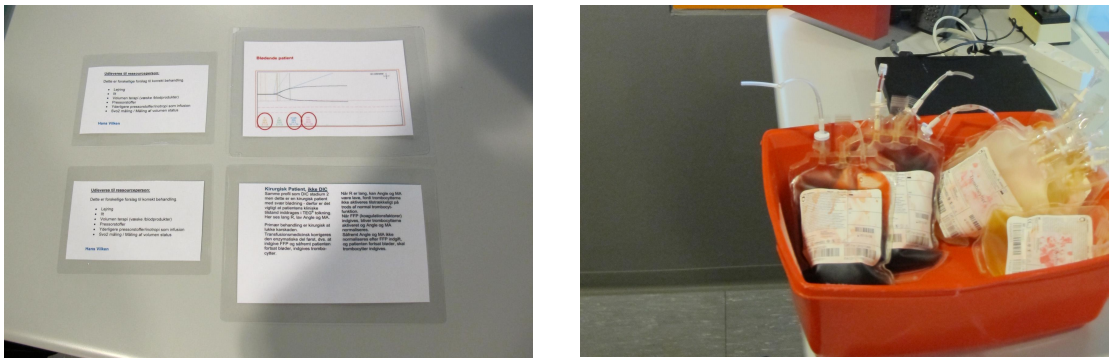

Figure 1. Left side: posts that describe medical-specific situations and which are given to participants during life-saver interventions. The participants are supposed to consult the information inscribed in those posts and adjust their actions accordingly. Right side: fake blood containers filled with red syrup that are given to participants during life-saver interventions. These accompany the posts and participants' actions that follow after the consultation of the posts.

The left part includes some posts with medical-specific content that accompanied the performance of a particular life-saver at SIM. These posts and other artifacts, such as blood containers (right part of figure 1) were delivered by the control room's instructors to the – participants. Such delivery entailed additional verbal instructions. The development of those additional artifacts and their relation to life-savers indicates the partial reification of a critical

event's potential unfolding. In other words the development of such artifacts is based on the prior experience of instructors with recurring uncertainties during role-plays.
As mentioned above, such uncertainties are related to the performance of each role-play but also to the knowledge of instructors on whether a role-play represents the potential performance of a critical event in a care delivery setting. Therefore, such artifacts are material instantiations of the boundaries in which critical events take place in care delivery. Thus, the development of artifacts that support life-savers and role-plays could also be seen as an activity through which instructors engage with the essence of critical events.
To briefly conclude the subsection on role-plays it is enough to mention that 1) critical events are performed by participants and instructors 2) the performance of critical events is based on sociomaterial relations that are mediated by objects with transformative capacities and 3) ithe engagement of instructors with uncertainties during role-plays entails further opportunities for their own understanding of the critical events' scope.

3. Developing scenarios during breaks and within corridors

Up until now scenario development has been examined in light of processes that took place during scenario design and role-playing activities. Such examination was based upon the references of instructors to scenarios that were generated during interviews and observations. These concerned the use of script-forms within the locations that constitute healthcare simulation center's (SIM) facilities. However, observations during a particular workday at SIM, where instructors engaged with the highest possible number of participants in role-plays (one hundred and thirty clinicians), revealed that the scenarios may potentially be at stake in other/additional locations and time frames. More particularly, it was observed that the premises upon which participants and instructors would engage with a scenario were reconsidered while instructors and participants were on *break* and while walking through or standing at SIM's *corridors*.
One of such situations is briefly analyzed below with the support of a vignette that draws on generated empirical material during the aforementioned day. Before proceeding to the vignette it is worth mentioning that the clinicians who visited SIM had been working for a university hospital, in the abdominal surgery ward. During that day: 1) the clinicians were separated in groups and each participated in two role-plays which depicted critical events that could take place during abdominal surgeries 2) after the de-briefing of the first role-play participants and instructors had a common lunch break.

> **Two instructors, Gitte and Andreas head to the buffet through one of SIM's crowded corridors where instructors and participants talk to each other loudly. Being disturbed by the crowd's noise they stop under a door frame that belongs to one of the control rooms. There, they use the surface of the door for placing the notes that they had taken during the last role-play and they begin to discuss how the previous role-play and debriefing stages proceeded.**
> **It came as a surprise for both instructors that during de-briefing the participants asked explanations about what was so critical in the event that they were supposed to deal with during the role-play. Some even referred to the whole situation as "too easy".**
> **Thinking aloud about the forthcoming role-play and debriefing, Andreas suggests to Gitte that the participants should be guided to explain to each other why they think that they deal with critical events so effectively during the next debriefing and why they seem easy to them. For Andreas this *easiness* is an excellent opportunity to lead the participants in a discussion of a critical event without focusing on errors**

and therefore without blaming each other. In response to that approach Gitte suggests that the role-play was "too easy" for some of the participants, such as the two surgeons. Gitte has also noted some of the phrases that they used during the debriefing and upon which all participants remained silent: One of them said: '*When working I am never stressed'* and the other mentioned: *'When operating there are no grey areas of communication, things are either black or white'*. Gitte believes that "spicing up" the surgeons' roles during the forthcoming role-play may make them less dominant during the debriefing. Andreas agrees on that, but they are now both puzzled: In what ways could they "spice up" only the surgeon roles? Their life-savers address other kinds of challenges. Before deciding about it Andreas and Gitte split. Andreas goes to have lunch together with other instructors and seek inspiration. While lying with her back on the door Rikke looks for the older of two the surgeons. While observing the crowd that walks and talks in the corridor she thinks: *How the heck he manages to control his stress when he operates a patient and while more patients are already waiting for their turn?*

The above vignette provides the empirical ground for discussing several issues. In keeping with the focus of this section on the development of scenarios, some things are worth to be mentioned and these regard the material properties that enabled the two instructors to explicate and share their perspectives, to contemplate and to take decisions.

Doors (and doorframes) and breaks for lunch, among other things, do not just indicate a transition from a location to another and from one activity to another but also a transition from a seemingly complete scenario that is ready to be used into a *potentially contested* one. For the two instructors, such potential contestation was an important issue upon which they shared their perspectives with additional support from notes. It was crucial because their performance of their participants during the previous role-play did not just challenge the critical event but it also hinted to the group-dynamics that participants brought with them from the abdominal surgery ward. Therefore, the scenario continued to be developed under the doorframe. Such development concerned the attempt of instructors to (immediately) integrate the group-dynamics that could not have been predicted during scenario design and/or during the previous role-play. Questions on whether such integration is a matter of experimentation, spontaneity and positive opportunism are relevant but they will remain open until the concluding section of this case study.

To account for the transition between seemingly complete and potentially contested scenarios it is worth considering the liminality of corridors and lunch breaks. A helpful resource is Iedema and his colleagues' examination of clinical communication at hospital corridors with support from the notion of *liminal spaces* (Iedema et al. 2010, see also Chapter 2, Section 2.2).

In light of the vignette, during the lunch break the corridor enabled instructors and participants to transit from simulation and control rooms to the buffet but it also acted as a location that allowed instructors to reconsider the performance of the role-played scenario and therefore enabled them to take steps toward the anticipation of the forthcoming one.

Simultaneously, the corridor allowed instructors to choose a particular location, a doorframe and the door's surface, from where 1) they could share perspectives while drawing on their notes, 2) maintain some sense on what was going on in the corridor and 3) even use it as a point from where they could begin to take further steps toward the re-framing of the forthcoming scenario. Borrowing Iedema and his colleagues' words (2010, p.26) the door's surface and the doorframe provided *a spatial recourse for the enactment, the negotiation and therefore the management of complexity*.

1) Regarding perspective sharing, the door and doorframe provided a surface in which instructors had the chance to integrate parts of their notes in the scenario while also sharing their individual perspectives. Even though these perspectives differed from each other they co-existed and, to some degree, acted as indicators for the instructors as to the boundaries within which the scenario would be developed further. 2) Regarding the maintaining of sense, the door-frame provided a semi-isolated environment that allowed instructors to discuss intimate matters, such as the "spicing-up" of their strategy. The position of the instructors' bodies, facing the door while drawing on their notes, made visible to pass-byers the presence of instructors while discouraging any attempt to interrupt them. 3) The door and the doorframe allowed instructors to immediately reconnect with others, such as fellow instructors and particular participants and (to try to) involve them in the scenario's development in different ways.

What do the above considerations mean for the involvement of instructors in the (continuous) development of the scenario? A way to think about it is to consider the potential transformation of the critical event in the forthcoming scenario. In an attempt to actively participate in such transformation instructors integrated group-dynamics in the "incomplete" critical event. In doing so, 1) they assessed to what degree group-dynamics would contest the assessment of the critical event, 2) then they isolated different and yet-particular relations that they could intervene in by means that were not part/mentioned in the completed script-form and finally, they 3) took actions towards such an intervention prior to role-play by engaging other parties in it, such as the instructors and the thoughts of the participants. In this way the material aspects of corridors, doors and doorframes allowed instructors to think about participation in critical events differently than what they expected or than what was anticipated in the script-form and to take a step further and try out their own way of thinking in practice. The cost for doing so is the uncertainty and the experimental aspects entailed in instructors' decisions to "spice-up" the scenario. However, these aspects could also be understood as ways through which instructors relate to their incomplete objects of design while gaining greater knowledge about the complexities that (will) constitute them.

4. Healthcare simulation and medical students

The above sections have approached the constitution of critical events through an examination of scenario development in scenario design sessions, role-plays, lunch breaks, meeting rooms, control and simulation rooms, corridors and door frames. A common aspect in all those aspects was the engagement of instructors and participants with particular material properties that embodied scenarios. Such engagement has partially defined the context of instructors' daily work and use practices. The practices of medical students who work at SIM as operators of the mannequins (or simulators) allows for an additional approach to the role-played critical events. This brings attention to the effects that scenarios generate for the students[32] and to additional roles that SIM plays in the training of novice clinicians.

Two aspects will be illustrated and briefly considered. The first (1) concerns medical students working as operators and their relation to SIM and how such position has contributed to their approach with critical events. The second (2) has to do with the medical students'

[32] Under the role of the operators thirty medicine students were officially engaged with SIM and operated the mannequins' (or simulators') software program during role-plays. During the observation period at SIM such position was sometimes taken by instructors but more often was taken by medicine students who officially worked at SIM for some hours per week.

appropriation of SIM's facilities for training during medical-courses while training one another with support from critical event scenarios.
1) Before a medical student becomes an operator at SIM (s)he receives a short-term (two days) training about the program that supports the function of the mannequin (or simulator) and about the stages in which those role-playing activities take place at SIM. During the role-plays the students/operators sit in the control room from where they control the mannequin's functions by consulting the scrip-form's relevant categories (e.g. simulator set-up) and by receiving orders by instructors about any changes on-the-fly. In this way the operators are able to participate in various role-plays that each concerns a particular critical event. While discussing the benefits of working as an operator at SIM, a fifth-year medicine-student narrated the following incident that took place while being at a hospital for other educational purposes:

> *"I was at the hospital's anesthesiology department and the team that I observed was called to deal with an unstable patient during an operation. I was next to a young doctor who was supposed to be the team leader and observed her. She was not sure whether the patient was under a cardiac arrest and if her team needed to resuscitate him. Was he dead or alive?-she wondered. Many of the surgeons who were around had a suspicion that the main artery in the patient's abdominal area was ruptured. Then they actually stood a bit further and talked for a couple of minutes thinking that the patient is dead when one of the surgeons realized that the patient still had a pulse. Then they had to jump back and start treating him. I was able to see that when people are in uncertain situations they do not act under the algorithms that they are trained for such as first to assess the patient's condition, then to resuscitate him and then do the ABCDE (Airway, Breathing, Circulation, Disability, Exposure). Instead, they start to mumble like: 'it could be nice to do this but we could also do this'. They act a lot more on feelings in acute situations."*
>
> Medicine student/simulator operator

While the student's approach towards the clinicians may seem judgmental it also illustrates a situation where he was able to appreciate his relative distance from the patient and the rest of the clinicians (he was an observer). He understood such distance as part of a learning experience. In doing so he was able to critically discuss the doctors' approach by putting the algorithmic way of thinking into perspective. As an operator he had experienced such way of thinking in numerous role-plays with one of them being the one that was described in the CSCW article about the ABCDE approach (CSCW article, subsection 6.3, vignette 1).
2) Under the auspices of the Danish medical students' union some of the students/operators have developed a particular role-play that is offered to other medicine-students in the form of a simulation course. The course concerns sixth-year medical-student training in acute patient treatment and aims to support their preparation for a practical examination. According to some of the students/operators, during the role-play that supports this course the participants are able to try how to give orders to other colleagues, how to work in teams and how to deal with a cardiac arrest in practice. As Ole put it: "What do we do when we stand in there [the Operating Room]?"
The simulation course takes place four times per year, during weekends – when SIM does not host any other activities. In such setting, some of the operators facilitate the role-plays and their de-briefings by using the control and simulation rooms in the premises of SIM. Any

facilitation skills the students/facilitators have are not officially documented and are acquired through the experiences they had while working at SIM as operators. But along with such skills the facilitators also acquire a set of concerns that regard their relation with the participants/fellow students. According to Ole the main challenge is in the debriefing where as a facilitator (s)he is not supposed to tell participants what they (potentially) did wrong. Instead, the facilitator has to think:

> *"How would I try to ask participants about this particular thing so I can lead them to come to this particular conclusion that I think is interesting?"*
>
> Medicine student/simulator operator

This example illustrates medical-students' *appropriation* of SIM's facilities. On the one hand, such appropriation entails purposes that exceed the SIM's formally stated intentions to offer official and qualified training to novice and experienced healthcare professionals. On the other hand, such appropriation supported students/participants to prepare for an official examination that would contribute to their qualification as medical doctors and, additionally, supported students/facilitators' engagement with parts of instructor-related work practices, such as scenario design, role-play facilitation and debriefing. From this perspective the students/operators drew on their practical experiences with the role-play of critical events and developed a process that would support their qualification upon acute patient treatment. The above example of students' engagement with SIM's workings has illustrated how SIM becomes a reconfigured entity (Suchman 2007) through its sociomaterial properties. Such reconfiguration has allowed critical events to become learning objects for actors, such as the operators, that have been partaking in SIM's official processes as intermediaries.

5. Short conclusion

Sections 2 and 3 have provided an analysis of critical events that focused on how these become transformed during the continuous development of scenarios. They also focused on the effects that such transformation had for instructors' engagement with them. Section 4 examined the transformation of critical events into learning objects for students through the latters' appropriation of healthcare simulation center's (SIM) locations and sociomaterial properties. The analyses of those sections have pointed to particular aspects that render the development of scenarios in healthcare simulation as a patient safety assemblage.

During scenario design the transformation of critical events into elements of scenarios took place through the problematization and framing of the relations that rendered those events as critical in care delivery settings. Central to such problematization and framing was the inclusion and exclusion of relations that would allow an event to appear as critical during a role-play. In doing so, instructors drew on the their experiences with care delivery settings in defining the relations between participants and critical events and their own relation to the latter. This process resulted in the generation of new scenarios but it also provided instructors with an opportunity to become aware of the scope of the particular critical event that they designed. This was the first indication that scenario development did not just concern the learning of participants about patient safety through training but it also concerned the development of collaborative knowledge practice among instructors. Such practice allowed instructors to relate to patient safety in different ways than those they did when performing medial-specific work.

The case of the life-saver development provided a clear example of instructors' attempts to generate an additional approach to scenario design processes (e.g. workshops) for dealing

with some expected uncertainties. Despite the anticipated contribution of such an approach to the smooth performance of scenarios during role-plays (by including only the uncertainties that instructors wanted) it also allowed instructors to consider further the scope of the critical events that they have been *designing into* scenarios. What is important here is that the development life-savers may take place within scenario design but also *after* several role-plays of a scenario - when instructors are more sure about the uncertainties that they generate during its performance. The development of life-savers can be understood as a process in which patterns of uncertainties (during role-plays) are identified and feed the continuous development of scenarios.

During role-plays the transformation of critical events from script-form categories into a set of sociomaterial relations took place through the engagement of instructors and participants with particular material instantiations of critical events. In doing so, instructors put efforts into coordinating and adjusting their facilitation activities with participants' interactions and with artifacts that together, constituted critical events within the simulation rooms. Central to such process was the fluid, incomplete and yet-multiple nature of critical events which held (different) uncertainties for participants and instructors. The examination of critical events as fluid hinted that each role-play results into a slightly different performance of a critical event and the differences between such performances indicate an additional scope for appreciating critical events. However, the scope that was referred in relation to scenario design differs from this one. This is because the scope of critical events during role-plays entailed instructors' negotiation, anticipation and alignment upon complex and unfolding interactions of humans and non-humans and not only upon instructors' experiences. Along with such processes the collaborative knowledge practice of instructors became also transformed. This is because instructors remained open to participants' performance of critical events and, to some extend, they followed the course of such performance instead of only attempting to bring it "back on track".

The analysis of critical events' further transformation in corridors and lunch breaks provided a detailed example of how group-dynamics that have been shaped in care delivery settings became integrated into performances of incomplete and fluid scenarios. Central to such process was the door and doorframe material properties. These allowed instructors to rethink their own and their participants' roles in ways that differed from what was anticipated in the script-form. The above-mentioned artifacts and locations allowed instructors to consider their roles as parts of an unfolding complexity while having a creative and experimental outlook and not only attempting to eliminate such complexity (at least not in the same way that life-savers would allow).

Finally, the short examination of medical-student engagement with critical events illustrated a case where the appropriation of SIM's facilities and workings resulted into the transformation of operators into facilitators and participants and therefore the transformation of intermediaries into actors. Central to such transformation was the reconfiguration of critical events into learning objects for all human actors, whether they were participants and/or facilitators. The case analysis made clear that SIM encompasses various sociomaterial practices, which in turn, render it as an entity that cannot be defined as a context (see IOM's mention at the beginning of the case analysis) upon which critical events constitute clear-cut tools for patient safety training. The sociomaterial practices that SIM entails shape particular aspects of patient safety. An understanding of the effects that such shaping generates for patient safety practices requires the constant and simultaneous consideration of healthcare simulation in light of care delivery and vice versa. This requires additional focus on the ways that clinicians engage with patient safety under the broad and complex role of instructors.

Case analysis 2: Young patient hygiene, play and teaching at a mother-child healthcare facility

Introduction and structure

While the previous case analysis focused on the involvement of clinicians to the simulation of critical events this case analysis focuses on the involvement of clinicians and non-clinicians to a particular aspect of patient safety within care delivery settings. This case analysis concerns young patient[33] hygiene at a mother-child healthcare facility (hereafter facility) that is situated within a Danish university hospital. More particularly, it examines the development, maintenance and transformation of *assemblages* that enable young patients to *play* and/or to be *taught* without risking the acquisition of hygiene-related infections. The analysis of those assemblages is supported by empirical material that was generated at the facility through observations, interviews and a workshop; all concerned the daily work of *non-clinical professionals*. Furthermore, the analysis is also supported by the drafted article that is currently entitled: *Toys and teachers in children's hygiene: examining non-clinicians' contribution to patient safety practices* (Balatsas-Lekkas and Mesman, drafted, appendix 2). Three cases are examined:

- The first is about the use of clean and unclean toys within special locations, *the playrooms,* where young patients are able to play with each other and with toys. The examination of playrooms concerns the involvement of pedagogues, ward-cleaners, parents and the facility's hygiene department in the development of processes for the cleaning/uncleaning of toys.
- The second is about the development and use of "clean enough" copies of educational material that support educational activities *in isolation rooms*. The examination of those copies concerns the involvement of teachers and the hygiene department in the development of a disinfection process that the former follow prior to entering the isolation rooms.
- The third is about the use of a spreadsheet that supports teaching activities at the facility's school and at various isolation rooms. The examination of the spreadsheet concerns the involvement of two teachers in the development of the spreadsheet and its categories.

The structure of this case analysis is as follows:

Firstly, the stage is set by drawing on and briefly elaborating upon sections 3 and 4 of the aforementioned article (Balatsas-Lekkas and Mesman, drafted). Secondly, a short motivation statement is provided that regards the study of the three cases by keeping a common point of departure in non-clinical work. Thirdly, the above-mentioned cases are examined with support from the same article's analysis and additional empirical material.

1. Setting the stage

The empirical backdrop of this case analysis has already been briefly mentioned in the introduction of this thesis (Chapter 1, Section 1.6), in the methodological chapter (Chapter 3, section 3.2) and in Balatsas-Lekkas and Mesman's article (drafted, section 3) and concerns young patient hygiene during play and teaching activities. Before proceeding with the analysis it is worth considering the context in which the securing of hygiene around toys, in playrooms, in wards and beds became a technical challenge for the facility's management. This concerns the early design stages of the new mother-child facility that, among other things, resulted in the

[33] With the term young patients I refer to hospitalized children at the facility from 3 to 12 years old. This is because older children (from 12 until 18) were using different areas for entertainment that are not part of this study. Whenever relevant, the children's particular ages will be referred to.

definition of 1) the main principles upon which the new hospital would be designed and 2) the main challenges that had to be solved.
During those early design stages the management had defined hygiene around toys as a challenge that concerned the workings of the new facility but also the ongoing engagement of young patients with toys in the current facility. Hygiene around toys concerned the new facility since one of the main principles was that of *Integrated play* where, according to management, it had to be integral in the design of the new facility and, generally, in the new facility's entire life-cycle. The following quote belongs to Mary, a managerial staff member and (project leader for the new facility) reveals how the management addressed the ongoing challenges of hygiene, toys and play:

> *"We have many difficulties with play areas because we have many different kinds of (hospitalized) children: some need to be isolated, some are not in isolation but they cannot be exposed to different bacteria. We have some very clean toys in cupboards that parents can take and bring them into the children's rooms but they (the children) cannot visit the play areas. They play on their bed or on the floor."*
>
> Mary – management and project leader

The quote summarizes some of the aspects that motivated this study to seek further access and to conduct empirical research on young patient hygiene during play. The first aspect concerned play areas and their definition in light of an observation that was made by a private consultant that *children play everywhere* (see Balatsas-Lekkas and Mesman, drafted section 3). The second aspect concerned a seemingly general approach to young patients as *children* while the latter's access to toys (and play facilities) was based on their treatment as (non) *isolated patients*. The third, of course, concerned the definition of toys as "very clean" as well as the processes through which toys become dirty, clean or very clean.

2. Short motivation statement

But why inquire about young patient hygiene and play by empirically departing from the work of non-clinicians at a healthcare facility? A brief answer to this question relates to the thesis' analytical approach to patient safety practices and knowledge. As mentioned in the methodological chapter (Chapter 3, Section 3.2), the thesis has drawn inspiration from literature that is informed by Science and Technology Studies (STS) *and* is concerned with the explication of *what works well* during care delivery, and therefore healthcare professionals' resources for strength (e.g. Iedema et al. 2013, Mesman 2011). The inspiration is drawn from clinicians' potential for creativity, their fine-tuning and alignment while treating patients. However, the empirically-informed analyses that support this literature mainly concern the work of clinicians, such as doctors and nurses. Very recently patient safety research that focuses on the explication of strengths has methodologically *and* analytically considered non-clinicians (e.g. Grant et al. 2016).[34] Drawing on this positive approach to patient safety practices this case analysis examines the constitution and boundaries of patient safety practices by taking into account practitioners that work at healthcare facilities and do not have a medical background (hereafter non-clinicians). The assumption that lies behind such approach is that patient safety practices may potentially be outcomes of heterogeneous and *interdisciplinary* processes.

[34] A broader literature review that focuses on the implications of non-clinicians' inclusion in research designs and analyses that address patient safety can be found in the Balatsas-Lekkas and Mesman article (drafted, section 2).

3. Playrooms and school classes as patient safety assemblages

Clean/unclean toys and "clean enough" copies of educational material were approached as *orderings* in the Balatas-Lekkas and Mesman article. This approach strongly supports this section. Below, a short review of the article's findings is presented and a further discussion approaches those orderings as patient safety assemblages.

Clean/unclean toys in playrooms

The analysis of the article approached the dichotomization of toys into clean and unclean as an ordering that was constituted by humans and non-humans and which reflected the approach of the hygiene department to young patient hygiene during play activities. The analysis of the efforts made by pedagogues and ward cleaners to include this dichotomization into their daily work revealed the emergence of two additional orderings: The one concerned the development and use of signs and the other concerned the use of racks. Each of the additional orderings contributed to the continuous production of clean/unclean toys by allowing (and restricting) particular interactions. Simultaneously, these orderings problematized the assumptions of the hygiene department about the contribution that the system with the red and green boxes had in the maintenance of the clean/unclean dichotomy. For example, the development and use of signs resulted in the *inclusion of parents* in the production of clean/unclean toys. However, the safe interaction of parents with toys was only possible through the pedagogues' introduction of artifacts that were not included in the hygiene department's technical approach (red and green boxes) to toys. Another example was the use of a rack *in addition* to the red and green boxes. The rack has supported the pedagogues' approach to an emerged challenge which regarded the *amount of toys versus available storage space.* In addition, the rack and its use also resulted in the involvement of ward-cleaners in the production of clean/unclean toys through decision-making: Ward cleaners had to empty the red boxes but also to choose particular toys to be collected from the rack (and the playrooms' floors).

Central to both orderings were the practical efforts of pedagogues toward the identification categorization, storing and collection of clean and/or unclean toys. These efforts invoked the emergence of various, yet local configurations of people, practices, artifacts and information. These configurations enabled a particular, yet continuous production of clean and unclean toys *despite* practical, spatial and temporal challenges.

"Clean enough" copies

Subsequently, the analysis in the same article (Balatsas-Lekkas and Mesman, drafted) approached the development of clean enough copies of educational material as a disinfection ordering that: 1) was also constituted by human and non-human entities and 2) emerged throughout a bottom up disinfection process that was initially developed by teachers and later became approved by the hygiene department. The analysis described the workings of such ordering as two transformative processes through which 1) teachers[35] became the users of the young patients' clinical environment and 2) isolation rooms became temporary classrooms. Throughout the first process teachers were engaged in the use of various clinically and non-clinically related artifacts at different locations for the production of a "clean enough" copy of

[35] During fieldwork there were working two teachers at the facility. As it is explained more thoroughly in Balatsas-Lekkas and Mesman's article, these two teachers became aware about the production of "clean enough" copies from their predecessors.

educational material (e.g. pages of a book with mathematical exercises for elementary school attendees). Throughout a process that required the teachers' scrubbing and cleaning of the copy with alcohol-based liquid both (teachers and copies) accessed to isolation rooms while preventing bacteria to enter *with either* of them. *Simultaneously* with the teachers' transformation into users of clinical environments, another transformation was taking place: isolation rooms were transformed into temporary school classes. This entailed the teachers' approach of young patients not as suspects of (potentially) having airborne infectious diseases but as students. Through the work of the teachers and their interaction with clean enough copies, the young patients were engaged in activities that resembled their student life within clinical settings.

Exploring ordering, orderings and patient safety assemblages

As it has become clear by now the analysis of the article has been strongly supported by the notions of ordering and orderings.[36] Throughout the article limited references were provided regarding those notions with the most central being that of Mol and Mesman (1996). With an empirical backdrop to the feeding of babies at a neonatal clinic Mol and Mesman draw on the notion of orderings (p. 431-434) for: 1) analyzing the co-existence of practices and meanings that accompany the food of babies and their feeding and 2) foregrounding theoretical and methodological differences and similarities between the fields of semiotics and symbolic interactionism. The analysis of the Balatsas-Lekkas and Mesman article focused on the explication of practices and meanings around young patient hygiene during play and teaching activities. What has been left implicit in the latest version of this article (appendix 2) are the theoretical premises under which the notion of ordering is employed. A good resource for explicating these premises is Law's article (1992): *Notes on the theory of the actor-network: ordering, strategy and heterogeneity*. Law proposes that the notion of ordering may describe *effects that are generated by heterogeneous means* and that a particular effort at ordering encounters its limits, and struggles to accept or overcome those limits. Central to Law's approach is a relation between orderings and translation:

> *The object is to explore and describe local processes of patterning, social orchestration, ordering and resistance. In short, it is to explore the process that is often called translation which generates ordering effects such as devices, agents, institutions, or organisations.*
>
> (Law 1992, p.386)

Implicitly drawing on Law's approach to ordering and translation, the analysis of Balatsas-Lekkas and Mesman described the *production or coming into being* of clean/unclean toys and "clean enough" copies. As mentioned in the summary of the case analysis (see above section) such production entailed various interactions for those entities partaking in orderings. In other words, the article's analysis approached clean/unclean toys and clean enough copies as *ordering effects* rather than objects with some sort of capacity to mediate, such as boundary objects (Star and Griesemer 1989). In fact, one of the first issues that the analysis raised was that artifacts that

[36] Someone may ask: why was the notion of orderings chosen as the main analytical notion in the article? The answer, of course, is that *the shaping* of the article (analysis included) and its current form is the outcome of a close collaboration (negotiations also included) with the co-author (Mesman). Therefore the choice of orderings has been made while (co)considering the points that had to be communicated through the article to a particular audience. However, some of these points *also* contribute to this chapter and, generally, to the thesis.

were intended to support the cleaning of toys could be used neither alone nor by everyone. Furthermore, the analysis of human actor involvement in those ordering effects revealed the costs or displacements under which young patients were able to interact with toys, educational material and non-clinicians *without* invoking hygiene as a safety issue. The analysis' transition from ordering to *orderings* and vice versa was one way for directing attention towards the sociomaterial reconfigurations that allowed clinical and non-clinical work to co-exist *at particular spaces and during particular time frames or temporalities*.

But how do orderings relate to assemblages? To answer this question it is worth drawing on Marcus and Saka's (2006, p.102, see also Chapter 2, Section 2.1) approach to assemblages as analytical resources that may help one to address *the heterogeneous within the ephemeral, while preserving some concept of the structural.* As the authors explain further, assemblages are about relations between time and space that are constantly under movement and change and the formation of those relations can be thought of as puzzles.

Drawing on the notions of ordering and orderings Balatsas-Lekkas and Mesman explicate some relations between time and space. One example used in the article was the consideration of spatial and temporal frictions as properties of the clean/unclean toy ordering that invoked the emergence of additional and local orderings. Frictions were approached separately and each of them entailed particular relations of space-time. Throughout the temporal friction, it became clear that the relation between playrooms and young patient hygiene could potentially change throughout the day: It could be subject to pedagogues' and ward-cleaners' work resulting in the cleaning/uncleaning of toys *as well as* interactions between parents and toys that eventuated in the production of an uncertain toy status. Throughout the spatial friction it became clear that the cleaning/uncleaning of toys was taking place during the daily work of pedagogues and ward-cleaners and involved the use of the playroom and its artifacts *potentially in different times*. Another example was the consideration of the transformative processes that allowed and resulted from the production of the "clean enough" copy. The analysis of those processes made clear that the prevention of bacteria access to isolation rooms contributed to the transformation of the latter into "classrooms" and allowed young patients to relate with aspects of their life *not* pertaining to their clinical situation. The above are just some few examples of time-space relations that emerged through an analysis of ordering and orderings. Of course there are many other time-space relations that remained unaddressed in the article, such as those *in-between* temporal and spatial frictions.

The point is that the notions of ordering and orderings have led to findings that regarded the co-existence of and interdependencies between clinical and non-clinical work. The explication of the emergence of co-existences and interdependencies offered insights into the ways or contexts those young patients interacted with toys and educational material without rendering hygiene in playrooms and isolation rooms as a safety issue.[37] Thus, both notions offered insights about the conduct of patient safety work by 1) addressing the formation of the *heterogeneous* and interdisciplinary practices within *ephemeral* settings, and 2) accounting for the interactions and trade-offs that allowed the maintenance of safety *through the preservation of some concept of the structural.*

From a methodological perspective, ordering, orderings and assemblages have affinities with each other since their application to empirical material entails – almost by definition – some necessary de-punctualization of black-boxes (Latour 1999), be they practices, work or objects.

[37] These are described in detail in the article's analysis but also in its concluding discussion (e.g. relation of non-clinicians work with the notion of prevention).

4. Developing and using spreadsheets as ordering devices

The above analysis provided insights into the formation of interdisciplinary and heterogeneous practices between clinicians and non-clinicians and accounted for the contribution of those to the identification of an interdisciplinary patient safety practice. It did so by focusing on non-clinicians' interactions with particular locations (e.g. playrooms, and isolation rooms) and artifacts (e.g. racks and toys) and provided examples of where young patient hygiene was related to non-clinical daily work. However, such analysis focused more on the use of such artifacts and rendered non-clinicians' efforts as responses to the hygiene department's approach to hygiene. Perhaps, the example of the bottom up process (even with support from limited empirical material) hinted that non-clinicians do not simply use artifacts that are made available to them but they also develop artifacts and processes, such as the "clean enough" copy and its accompanying disinfection process.

The following analysis is an attempt to address further, and with some detail, an artifact that was developed and used by non-clinicians within healthcare settings. The empirical material that supports it has been generated during fieldwork conducted at the facility and concerns the development of a digital spreadsheet (e.g. an excel file, and hereafter spreadsheet) that both teachers were using for *organizing* their teaching activities.

Organizing teaching activities

The following summary describes some of the challenges that teachers addressed during their work for the facility[38] (three years) and attempted to deal with by developing and using a spreadsheet (see below). These derive from empirical observations of teachers' daily work at the facility and from an in-depth interview with both of them.

1) Teaching could either take place in the classroom[39] or within the rooms of young patients, be they isolated or not. The choice of teaching space for each young patient was made by clinicians and was based on their estimation of the overall health condition of the patient, including the latter's protection from hygiene-related infections. Of course, such choice could change throughout the course of a scheduled treatment. For planning teaching activities the teachers had to be aware of such choices and changes.

2) Within one working day a part of the teaching could take place at the room of a young patient and another part in the classroom. However, although the young patient rooms belonged to the same facility (the mother-child), they were spread in different floors and wings of the university hospital that hosted the facility. Without careful planning, the teachers' moving between the classroom and patient rooms could take time out from teaching activities.

3) The high volume of incoming and exiting young patients from the facility provided challenges for teachers who had to keep track, on a daily basis, of which of the young patients could receive teaching services, where they resided and for how long. For dealing with all of the above-mentioned challenges the teachers had developed a spreadsheet. Before proceeding to the structure and workings of the spreadsheet it is worth making some comments on those challenges. From a broad view all three challenges concerned the maintenance of *coupled relations* (Bossen and Markussen 2010) that would allow a smooth care treatment of young patients as well as their teaching. In other words, the organizing of teaching was a matter of

[38] Here it worth reminding that teachers were employed by the municipality and worked full time for the facility.

[39] As it is mentioned elsewhere, the classroom was situated at the ground floor of the university hospital that hosted the facility.

teacher participation in the maintenance of *orders* that had some bearing on healthcare settings and the course(s) of care delivery processes. The first challenge hinted to the coupled relation between doctors and teachers. Teachers had to know where can they visit their students and doctors had to know where their patients would be transformed into students. The maintenance of such relation in an unproblematic way could also be understood as a matter of coordination between clinicians and non-clinicians. The second challenge hinted to the coupled relation between teachers and *locations* with support from navigation. Without correct information about the locations and times that teaching could take place the teachers were taking the risk of not providing teaching services or performing scrubbing and producing "clean enough" copies in a rush (see Balatsas-Lekkas and Mesman article). The maintenance of access to information about locations could be also seen a matter of navigation. The third challenge hinted to the joint relation between teachers and logistics. Without access to the facility's logistics the teachers could not perform their own logistics, such as estimating the number of their students and their needs. This could also be seen as a matter of planning.
Of course, the above three challenges and their coupling relations were interdependent and unfolded simultaneously during the daily work of the teachers. An example of such interdependence was revealed during fieldwork when the teachers arrived at the room of a young patient but the patient was not in a position to receive teaching services. Then, the teachers began asking particular local clinicians whether there was any other child close by that they could visit instead and engage in teaching. Then, what is additionally common to the maintenance of coupled relations is that all those concern the teachers' searching for information and their alignment with various human and non-human entities. In this context, the development of a spreadsheet could be seen as the development of a *device* that would allow teachers to participate in the ordering of the aforementioned activities, that is an *ordering device*. According to Bossen and Markussen (2010):

> *'Ordering' describes the enabling and shaping effects of...artefacts, when it comes to formatting information, and aligning and articulating cooperation and work trajectories, but (importantly) does not presuppose that everything can be or become ordered…*
>
> (Bossen and Markussen 2010, p.632)

While the above quote illustrates quite accurately the relation of teachers' work with orderings that had some bearing on care delivery (e.g. through collecting and formatting information) it does not inspire any particular analytical approach to ordering devices. Enabling and shaping are effects, sure, but at whose/what expense do they become parts of ordering? Suchman, who has also been interested in the effects of ordering devices (2007, chapter 11) mentions some questions concerning ordering devices:

> *In which specific worlds are technologies of order production generated, how do they circulate, and who or what are their subjects/objects? What or whose agendas and interests do they translate, with what effects?*
>
> (Suchman 2007, p. 205)

The rest of the analysis aims at unraveling some of the spreadsheet's workings for providing some tentative answers to the above questions. How do the "worlds" that the spread sheet owes

its existence to look like? Firstly, the technical characteristics of the spreadsheet are presented. Secondly, the generation of particular categories that are parts of the spreadsheet is examined. Finally, the sociotechnical background upon which the teachers developed the spreadsheet is also described.

The structure and use of the spreadsheet

The spreadsheet could be found as a digital file in each of the personal mobile devices (e.g. mobile phone, tablet and laptops) that the teachers use while working, but also in their private life. It could also appear on the screen that was situated within the classroom (figure 2). It was saved in a world-wide-web space that belongs to a so-called cloud service and each of the teachers had the same rights for its modification and its reading. During the fieldwork both teachers consulted and modified it at different times. While the above information may not reveal yet any functions of the spreadsheet, they indicate that its development was based on the *appropriation* of information infrastructures that supported the working of teachers and their personal environments. In this way, the use of the spreadsheet problematized the boundaries between those two. However, it is important to mention that the spreadsheet was used only by those two teachers.

The spreadsheet's rows contained the categories of: school, at facility, blood infusion and meetings. Its columns contained the categories: facility, room and the weekdays from Monday to Friday. At its bottom side multiple and closed spreadsheets could also be seen, each of which referred to a particular week (e.g. week 8, week 9 etc.). On its right side one could see a legend with six coloured cells. The green and turquoise referred to the teachers' names, the blue cell included the word "common", and the yellow cell entailed the phrase "at school". The black cell contained the word "minus". The purple consisted of the abbreviation "CF" that stood for Cystic Fibrosis, an inherited disorder with numerous symptoms for lungs, pancreas, liver, kidneys and intestine.

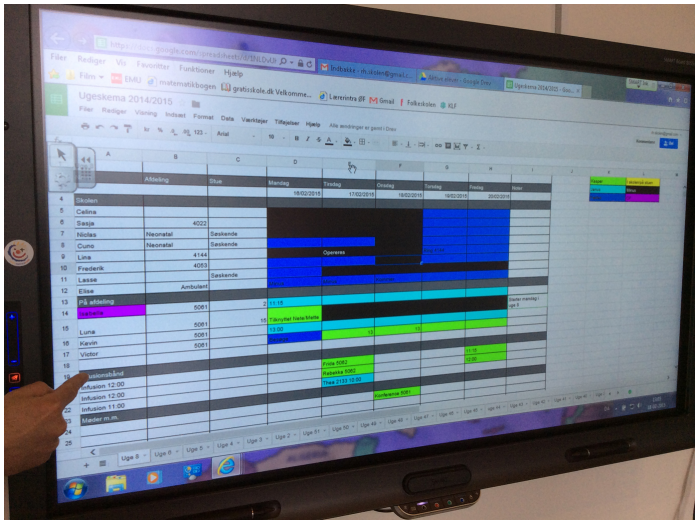

Figure 2. The spreadsheet as it appeared on the computer screen that was situated within the classroom.

Such structure may reflect the teachers' *classification* approach to the complexity that emerged from the three, aforementioned challenges. The locations, artifacts, social arrangements and conditions of patients comprise of a sort of classification system that according to Bowker and Star (1999):

> *is a spatial, temporal, or spatio-temporal segmentation of the world…is a set of boxes (metaphorical or literal) into which things can be put to then do some kind of work-bureaucratic or knowledge production.*
>
> (Bowker and Star 1999, p.10)

It is of special importance that the teachers had decided the elements of such system and that the system entailed medical conditions as categories. Taken together, those aspects indicate that the spreadsheet's spatiotemporal segmentation of the "world" has the potential to problematize and, in a more active mode, to reconfigure the boundaries between clinical and non-clinical work. But how does it feel to use the spreadsheet when dealing with complexity? Below, two examples are provided. Each example concerns one category of the spreadsheet that referred to the conditions of patients (blood infusion and cystic fibrosis).

Blood infusion

While asking one of the teachers about the spreadsheet's reference to the conditions of the patients the following dialogue took place:

> **Angelos:** I am just wondering…you have the categories cystic fibrosis and infusion that stand out as particular situations, like medical situations. And then you have other more spatial things like school or ward.
>
> **Teacher:** Yes, but infusion is also a space in a way, a space in time, because those children that are going through blood infusion might take teaching time from other children. Children under the process of infusion go to school four days out of five. Then our [both teachers'] view is that they don't need to be necessarily taught (while being at the facility)…if we do it is because a particular ward has asked us to do it…we work in different wards and the nurses fail to understand how many wards we go through. Then we have them calling us and asking us: "Can you come tomorrow and teach?". Sometimes we have to answer: "No, we can't, we have other students".

The above narration hints to the teachers' employment of the spreadsheet categories for supporting their particular prioritization scheme or agenda over that of others (e.g. nurses). In a way, such prioritization reflects the unique way that teachers participated in the "world" of clinicians. The inclusions and exclusions of potentially taught students became a matter of contestation and took place in light of the young patients' condition. If the example with the "clean enough" copy provided a case where young patients were transformed into students this is a case where a spreadsheet that was developed by the teachers allowed them to deal with potential students as patients with particular conditions.

Therefore, the categories entailed in the spreadsheet did not just support a neutral organizing of teachers' activities and work. The categories of the spreadsheet could be seen as elements of a *conscription device* (Henderson 1999) whose function allowed teachers to coordinate their work

by getting aligned with the interests of other actors in a particular way. Since the categories of the spreadsheet were closely related with the needs of teachers for particular information (see above sub-section) they also reflect the teachers' ontological approach and values that concerned relations of teaching and medical conditions.

Cystic fibrosis as a category

While Jan, one of the two teachers, attempts to explain the presence of the "CF" (cystic fibrosis) abbreviation to the legend of the spread sheet, he opens the old spreadsheets that refer to the work of both teachers during the last two years. Finally, he isolates 1) the spreadsheet that included data about the week before cystic fibrosis would appear as a category and 2) the spreadsheet that contained for first time the CF abbreviation . After that he mentions:

> *"The 28th of October 2013, we had two children with CF that could not be at the classroom at the same time. That is why we decided to do it (to include the category of the CF). To make sure that when more than one person is having CF, then it springs to mind immediately that you have to take special care of this situation."*
>
> Elementary school teacher

The above-mentioned special care concerns the nurses' and teachers' *shared responsibilities* toward the hygiene conditions of the young patients with CF for they are sensitive to sinus and other infections. Nurses had to ensure that the young patients with CF would leave from their wards by wearing masks and gowns and arrive at the classroom (ground floor) "scrubbed". The teachers had to make sure that within the classroom both young patients would retain a distance of more than 5 meters apart from each other and that they would not touch the same surfaces with bare hands.

The inclusion of CF as a category in the spreadsheet refers to the access of teachers to the world of clinicians. They did so by developing means for maintaining *awareness* about the health condition of their students and about the conditions under which teaching shall take place. In a case of teaching two (or more) young patients with CF teachers had to become *temporarily aware* of issues such as distance and touch that, in this particular case, concerned the safety of their students. Thus, the teachers had to temporarily depunctualize several black-boxes that concerned their own work practices. Then, the teachers would become "clinicians in their own right" – being able to diagnose and record their unique symptoms and to match those with the forms of treatment they have developed.

Teachers addressed the need of awareness by developing a *mechanism of anticipation.* This mechanism entailed the introduction of the category "CF" and its remaining on the spreadsheet irrespectively of needs for teaching young patients with cystic fibrosis. Unless a teacher would take a deliberate action to delete the "CF" category, both teachers would look at the category every time they would consult or update the spreadsheet. In this way the teachers were always able to punctualize and depunctualize their black-boxes and presumably maintain safety in classrooms when students with cystic fibrosis would visit them.

There are few more things that can be mentioned with respect to the CF category and its relation to the safety of the young patients. Firstly, it is worth mentioning that the particular category did not just exist but it *emerged* out of the teachers' need to re-adjust their own work practice. In this sense, the spreadsheet is an *evolving or multiple ordering device* for its categories and their

history are able to invoke the conditions under which teacher practices became interdependent with clinicians' work.

Developing spread sheets

As mentioned earlier, the spreadsheet was developed by the teachers. But why did they choose a spreadsheet as a solution and not something else? During the in-depth interview, one of the teachers mentioned:

> *"I am a librarian by education previously, so putting things in boxes...I am just obsessed by documenting…I mean I collect obscure records just because somebody has to own them, somebody has to have them, somebody has to preserve them. I grew up in a museum. My father made a local historical museum in the southern part of Jutland. So he collected all sort of old things."*
>
> Elementary school teacher

The teacher's answer provides some information about the sociotechnical background upon which the spreadsheet was developed. Its development was not just a matter of necessity and its shape was not accidental. Both took place due to the teacher's educational background and childhood experiences and not only due to the earlier-mentioned challenges and complexities. Perhaps this way of developing artifacts, which hints to a relation between needs and use, is mediated by additional issues that are more inherent to the developer's own experiences.
In addition: 1) The fact that the teacher related the development of a spreadsheet with the notion of records is important for it denotes an interest in remembering the past context of his own and his colleague's work. 2) Teacher's mentioning of records is also important for it denotes an interest in the collection of things, that is a materially mediated approach to information (that is usually thought of as immaterial).

The spread sheet as an invisible mediator of action

Following Suchman's approach to ordering devices (2007), the development of the spreadsheet and its employment for organizing teaching activities could be seen as an *endogenous resource for ordering* that is woven *into the fabric of the everyday activity* of teachers (Suchman 2007, p. 205). As such it is then, at once, invisible and a mediator in teachers' work and interactions with others. Then, the specific "worlds" from which the spreadsheet emerged are tightly coupled to the processes that allowed teachers *to classify and standardize* some of their relations with clinicians, their "students" and healthcare settings. Bowker and Star's (2000) scheme for understanding processes of standardizing and classifying provide a good generative structure for putting the above analysis into perspective. Central to such structure are four themes: 1) the ubiquity of standards and classifications, 2) classifications and standards as material textures, 3) the ways that standards and classifications reconfigure the past and 4) the practical politics entailed in standards and classifications.

Ubiquity

At first sight, the development of the spreadsheet could be understood as an attempt by teachers to *integrate* their work into the workings of the facility. The above-presented empirical material made clear that teaching was taking place in many areas that were also used by clinicians (e.g. patient rooms) at different times. In other words, there was an aspect of space inter-operability

between teachers and clinicians. However, Bowker and Star (2000) argue that an understanding of standards and classifications should also be based on the spaces that remain unclassified or excluded from such classification systems. Here is an example of such space: The spreadsheet included categories that concerned the teachers' relations to their students, sometimes through the latter's medical conditions. Excluded from such relations were the students' parents (or other guardians) as well as their needs and broader approaches to teaching.
The following narration by one of the teachers refers to an occasion where the parents of a recently operated young patient expressed a disinterest in teaching services. This shall suffice to illustrate the way that teachers established and managed their relations with parents with additional means:

> *"The parents think: 'Oh, our son (the young patient) can't handle anything; No teaching, no physiotherapy, nothing.' And they are very 'Oooh, wow little boy'. But he's 12 years old and the nurse said that he is perfectly fine, so we press the parents that he has to be taught. We [both teachers], are going to visit them at 12 o'clock Monday, because at that time they have their lunch and can't go anywhere…*
> *Our routine with every new student is that the parents have to fill out a form with the student's name, social security number, favourite teaching subject, interests and in what things he would like to become better…They are the experts on their child and in that way they feel involved because often they have so little control about what happens to their child (within the facility). But if we can come, go in and teach we give them some sense of normality and then it's a good thing."*
>
> Elementary school teacher

In regard to classification, two important things are worth mentioning. The first is that the spreadsheet may allow teachers to know where to find the young patient, but it is the form that will mediate the teachers' relation to parents. The second is that teachers may use the spreadsheet for standardizing their teaching relation with the young patients *only after* meeting the parents and convince them about the usefulness of teaching and after the fulfilling of the form.
Now it becomes more clear that the seemingly ubiquity of the spreadsheet can serve only as a partial basis or as a point of departure for explicating the "worlds" that brought it into being and it mediates. This is because the use of the spreadsheet and its development are mediated by many other artifacts. For as long as these artifacts mediate the work of those who also use the spreadsheet they need to be taken into analytical consideration.

Material textures
The description of the locations that the spreadsheet could be found revealed some of its material textures. These were the teachers' mobile devices and the classroom computer screen. One way to approach such texturing would be to conduct a sort of a banal critique about the spreadsheet's dependency on the Internet's stability within the facility. It could also touch upon the restrictions that concern the use of mobile devices in the facility. However, the aforementioned teacher's self description as a librarian who used to *collect* records has an additional importance. This is because the spreadsheet became an *invisible mediator* for the teachers' relation with young patients and clinicians through its capacity to retain a sense of materiality, such as the one that lies behind the idea of collecting records.

Thus, the ordering qualities of the spreadsheet that were discussed in the previous sections owe part of their existence to their developers' experiences with other devices and sociotechnical contexts of use.

Reconfigurations of the past

The examination of the CF category foregrounded the teachers' practical need to gain *temporal awareness* upon their own, taken for granted actions, such as touch and distance. Such awareness is what renders teaching of young patients with CF in the classroom a non-threatening activity for student safety. However, awareness is not just a state of mind. It involves the rearrangement of the class setting: Teachers do not just have to put the students to sit at least 5 meters away from each other, but they also have to inform the rest of the participants as well as those that may potentially have access to the classroom (e.g. parents). Then, teachers have also to consider their own physical position, for they are not allowed to stand in-between the patients due to risks of contaminating the students with airborne diseases.

What is fascinating is that the transfer of the "CF" cell (done by copy pasting) in each weekly spreadsheet has the capacity of making teachers aware of a reconfiguration that occurred in their practice at a given past time while it allows them to consider its consequences in the present context of work. Central to such reconfiguration is the capacity of the spreadsheet to hold records and to represent cystic fibrosis in a particular way (e.g. one cell with a particular color) and the ability of teachers to recall those records only when they want. It would be quite perplexing, or even impossible, for others to explain the meaning of the information entailed in the spreadsheet.

Practical politics

Bowker and Star (2000, p.161) mention that once a classification system is in place, the practical politics of the decisions that allowed its generation are buried in archives or built into software. Considering the above section this holds some truth, but considering the teachers' use of the category of blood infusion it becomes understood that the spreadsheet's classification structure allowed teachers to deal with the practical politics of their work. Every time that the teachers had to make a decision on whether they would teach a young patient undergoing blood infusion the cell blood infusion reminded them the potential consequences of such decision. On the one hand, they would teach a student at the expense of other students. On the other hand, if they would teach a young patient undergoing blood infusion, they would potentially maintain good relations with the ward's nurses.

Case analysis 3: Addressing patient safety at the early stages of design processes. The case of Innovation Units.

Introduction and structure

The previous two case analyses explored assemblages of patient safety by focusing on the development of scenarios for the simulation of critical events (case analysis 1) and on the maintenance of young patient hygiene during play and teaching activities (case analysis 2). This case analysis explores the constitution of an assemblage where patient safety is the point of departure in the development of new devices and services. It does so by examining how, and at what expense, clinicians in their daily work in healthcare settings become involved in explicit development processes of medical devices and services that entail aims of patient safety improvement.

It focuses on professionals that have bearings on design practices (e.g. industrial designers) and follows their interactions with clinicians that take place within small organizational departments, the Innovation Units, which are situated within various Danish hospitals. It draws on empirical material that concern the establishment of a so-called Innovation Unit (IU) called Creative Works within the premises of a university hospital.

The structure of this case analysis is as follows: Firstly, it provides a general introduction to Innovation Units and foregrounds the broader scope within which they approach patient safety. Secondly, it focuses on Creative Works and provides a brief context that regards its establishment within a university hospital. Having the establishment of Creative Works as a backdrop, the case analysis examines three premises that allow clinicians and IU staff to collaborate during the early stages of developing devices and services for employing safety. The first concerns the idea of *innovation* within healthcare settings and the consequences that arise for the framing of patient safety as a multi-stakeholder product development activity. The second deals with the translation of clinician *ideas* and challenges into interdisciplinary *projects* and the translation of clinician challenges, when dealing with patient safety, into a problem-solving process. The third deals with the employment of *workshops* as a method for engaging clinicians in the transformation of the above-mentioned challenges into projects.

1. Innovation Units

Innovation Units (IUs) are small organizational departments; situated within existing healthcare settings, such as hospital campuses and are spread in different regions across Denmark. Their development, which begun in 2006 and continues until the present day, is part of a broader attempt made through Danish policy-making initiatives to encourage innovation in healthcare and more particularly user-driven innovation (Røtnes 2010). While not being the sole purpose of IUs, these often *initiate projects* under explicit aims to contribute to broader quests for quality and safety improvement in healthcare. Such projects concern the early stages of product and service development within existing healthcare settings. These stages refer to the identification of areas for improvement within healthcare settings, the generation of ideas, the conceptualization of those ideas and the development of drawing and prototypes. Since 2006 IUs have initiated and taken part in projects that aim to deliver safer care by for example 1) involving nurses and doctors in the development of monitoring technologies that could minimize acute entries in hospitals, 2) involving clinicians who worked at pediatric clinics in the testing of software applications that aimed to coordinate the individual and collaborative work of clinicians in acute situations of birth giving (e.g. cesarean section).

Throughout these and many other projects professionals with bearings on design, such as Information Technology (IT) specialists and industrial and service designers, engage clinicians in the development of new products and services. In doing so, IU staff make use of particular methods, such as user-centered workshops, idea boxes and prototyping sessions with users.
Interdisciplinary collaboration and user involvement may constitute an obvious way among designers, and others who work for IUs, for developing medical devices and services. After all, local medical device manufacturers have been promoting these and similar ways of working across design and healthcare. However, when such approaches become part of healthcare settings they entail the implicit requirement from clinicians and other healthcare workers to recognize that new modes of interdisciplinary collaboration have some value for their own daily work. The benefits and potentials of such collaborative work may not necessarily be obvious for them.
The establishment of IUs within healthcare settings and the particular methods that come along with them are worth scrutinizing, since they are both parts of an *emerging context* where patient safety becomes a concern. Central to such context is the interdisciplinary collaboration between clinicians and IU staff members. What needs to be explained concerns 1) the ways that patient safety becomes a concern in such interdisciplinary collaboration settings 2) the transformations or translations that allow clinicians and IU staff members to collaborate.

2. Creative Works

The birth of Creative Works

> Creative Works was born in 2007 in a city and its establishment as part of the city's university hospital was an uncertain process. According to its founders-to-be, the initial idea behind Creative Works was not too much "user-oriented". According to the university hospital director of research and management who would host Creative Works its "concept of innovation" was not clear. These comments led the Creative Works project managers to reconsider its scope and purpose. While their initial idea was that Creative Works would support the users of the city's university hospital with innovative devices and services, they decided to re-address its scope. Instead of developing devices and services for the university hospital, Creative Works would do so for the whole surrounding region. Finally, after a successful co-funding application the project managers of Creative Works hired a mechanical engineer, a legal counselor, a lawyer, an anthropologist and two service designers.
> During the first month of operation, they launched a campaign for collecting ideas from clinicians that worked at the university hospital. Soon three issues became apparent to the team: 1) The university hospital's management did not have any specific ideas that the team could work with, 2) clinicians begun sharing with the team some ideas and challenges that fell out of Creative Works scope, such as the lack of parking space at the university hospital and 3) while some clinicians shared a few ideas about improvements that concerned care delivery at the hospital, they were disinterested in joining the Creative Works team and develop their ideas further.

The above empirical account may seem distant from ongoing issues of quality and safety. The point here is that the establishment of Creative Works within the university hospital and the early forging of relations with clinicians allows insights into some of the premises upon which collaborative work has been taking place between Creative Works and clinicians. The appreciation of these is important since they already lead the early development stages of devices

and services toward *safer* care delivery. In other words, the explication of such premises has the potential to make visible some of the processes that are generated within healthcare settings through which patient safety becomes part of unfolding *objects of design* (Binder et al. 2011a). Examples of those devices are many, such as the development of a nasal catheter for newborns and the development of a system that prevents errors in blood samples that are transported from one healthcare facility to another. Having as a backdrop the above account (Creative Work's birth) these premises are explored. The first deals with the idea of innovation within healthcare settings, the second deals with the translation of ideas into projects and the third deals with the method of workshops.

Innovation

One of those premises is the idea of *innovation*. Inherent to the birth of Creative Works was the assumption that innovation that would result in the development of products or services could begin within healthcare settings but its latter stages would depend on other, potentially private, stakeholders. Approaching innovation in healthcare through public-private partnerships is not uncommon and it was actually encouraged by the Danish ministry of Economics and Business (Røtnes 2010, p.24). However, projects that are initiated within healthcare settings under the explicit aims of improving safety do not just become interesting for private and other stakeholders. The following empirical example illustrates this:

> Creative Works has become well known at a country level for the development of a particular medical device, a nasal catheter. Throughout its early development stages it became clear to the Creative Works team and the nurse that had the initial idea that the most efficient way of helping newborns to get extra to oxygen is a nasal catheter.[40] While the design of the catheter was praised by local media and designers, it did not become an actual product in the country of its origin (Denmark). Instead, it firstly became produced and used in a southern European country. According to the Creative Works' former portfolio manager the reasons were complex but mostly concerned the manufacturing costs vs. the amount of devices that would be bought and used in the country of its origin.

This brief example illustrated a case where an artifact that could potentially contribute to the reduction of risk in healthcare settings had to be *transformed* into a product and this resulted into its production and use in another country. A series of reconfigurations take place along such transformation and concern the framing of patient safety. Initially, newborn exposure to the risk of lack of oxygen was the main reason for the nurse and the Creative Works team to develop a new artifact. As soon as such artifact became a concern for the manufacturer, the safety of newborns became reconfigured.

For the potential manufacturer of the nasal catheter the latter *is not just* an intermediary (Callon 1991) between the newborn and oxygen. It is much more: it is an entity that is made of materials that have particular properties, it requires a series of tests that concern its quality, its functionality and its usability. Ultimately, it has to become part of existing markets and to be qualified (Callon et al. 2002). As such, it has to become aligned with particular "laws", such as pricing, where its price needs to be affordable for its potential *buyers*, such as hospitals. In turn, this requires from hospitals to compare it with other *products* or solutions and to estimate its

[40] Alternative solutions that have been rejected concerned the use of oxygen masks for adults or oxygen masks that would be placed in/integrated with the newborn's pillow. Both were rejected due to the increased risk of newborns ending up with not getting the necessary oxygen.

context of use which, in turn, comprises of an estimated number of patients that would need the support of such device. Considering the above, the nasal catheter needs to be manufactured in quantities that would satisfy a particular amount of buyers and patients without ending up being stocked for a long time in the manufacturer's warehouse. The above just illustrate some reconfigurations along with the transformation of an idea into a product: hospitals become buyers, patients become users and part of a potential market, the product becomes a matter of material processing and also an entity that occupies a particular space.

Ideas and projects

The account about the birth of Creative Works and the example with the nasal catheter revealed another premise that has accompanied by the framing under which Creative Works and other IUs operate. This concerns the notion of *ideas* and their treatment throughout the innovation processes that take place within healthcare settings. The account about Creative Works' birth has already illustrated that ideas were expected to come from clinicians' daily work but the application or relevance of those ideas had to be as broad as the region that the hospital (and Creative Works) belonged to. The example with the nasal catheter has also made clear that ideas from clinicians might be born out of a challenge that concerns a particular space but their further appropriation requires them to travel much further than such space or the hospital's region. These empirical insights bring attention to another reconfiguration which concerns the treatment of patient safety among clinicians and IUs. This could be briefly explained as a matter of idea generation towards the solving of particular challenges. But how does the "travelling" or translation of ideas take place within the spaces that these challenges are born? The following quote belongs to an interviewed service designer who worked for Creative Works and provides some insights into how ideas are born, are moved forward and some further implications:

> *"We [Creative Works' team] will have to talk to whoever sent this challenge to us. It might be the hospital's management, or a nurse. Then we talk to them about whether we should make a project out of this. What the organization should be like? Who is the owner? Who is the project manager? So, we try to get some idea of what is that we want to work with and then… We try to gain insight into the challenge, we make interviews, we do observations, we need to see what are the working processes, we need to get a very, very thorough idea of the context that we're working with…And one more thing. I think it's also the data that the product [under development] might require, is not necessarily the sort of data that we do [collect] in the beginning of a project, where we have absolutely no idea about what the product is going to be in the end… We might develop …a solution and then that solution doesn't necessarily connect to the data that we got in the beginning [of the project]."*
>
> Alex, service designer at Creative Works

Alex's quote brings forth many interesting issues that concern the translation of an idea into a *project*. Firstly, the quote illustrates that the Creative Works team interacts with the care delivery settings through a particular set of methods, among those being observations and interviews. Those methods do not just contribute to the translation of ideas into a work context for the Creative Works team (see also below). They also provide a set of particular relations under which challenges of care delivery are framed. The work of clinicians is translated into collected data. In turn, as the quote reveals, this data may provide a direction with respect to the project

but the latter may change at a later stage. Secondly, the quote illustrates that accountability for each project comes at the very early stages where the future of an idea is still ambivalent. However, the important thing is not the idea's uncertain future but the context in which clinicians and others become *enrolled* (Callon 1986) in dealing with challenges, potentially referring to safety. Such enrollment requires from clinicians to partake in negotiations about the responsibility of ideas that simultaneously become translated into projects. Here it is worth reminding that the explicit aim of IUs is to develop services and artifacts. While a project-approach to challenges that may concern safety does not necessarily yield implications, it needs to be noted that the IUs are determined in developing new things, be they artifacts or services. What remains excluded, or at least underestimated, from such fixation is the appreciation of opportunities that may emerge for dealing with challenges *throughout* the unfolding of a project. A resource that is helpful for accounting for project unfolding is Nocker's (2006) notion of *project horizon* that she describes as *a multiple space of performance and jointly created meanings about 'what the project is about'* (Nocker 2006, p. 135). An understanding of Creative Works projects as s*paces of performance* requires a sense of the premises under which actors, such as clinicians and ideas, become parts of them. The following subsection provides some insight into the function of workshops.

Workshops

> *"The nurses that came to us with ideas were very quick to say: 'I'm giving you this [challenge] now, I hope you can do something with it'. What we [Creative Works team] did was to persuade them…to enter into a dialog… by inviting them to workshops and presenting ourselves as facilitators and positioning them as the experts within their specific domain."*
>
> Christina, Creative Work's co-founder

It could be argued that workshops are particular methods that, together with the aforementioned interviews and observations, comprise the toolbox of the IU's team.
However, the above quote allows for an approach towards workshops under the influence of the *interessement* notion (Callon 1986). Employing workshops as *interessement devices,* the Creative Works team *persuaded* clinicians to partake in the transformation of ideas into projects while acknowledging a-priori the clinicians' expertise. While the quote does offer insights about what such expertise was about it hints that workshops allowed an initial definition of boundaries between IUs team members and clinicians and this was due to the latters' persuasion.
One could also argue that the transformation of ideas into projects also took place throughout the above-mentioned conduction of interviews and observations (see above subsection) where Creative Works team members became data collectors in clinicians' workplaces. Here it is worth reminding that the metaphor of collecting data often relates to assumptions about the neutrality of the methods that accompany the collection and processing of data (Alvesson and Skoldberg 2009).
The transformation of ideas into projects through workshops required the Creative Works team to become facilitators and clinicians to become experts. Such positioning entails the mediating role of the workshop in the *qualification* (Callon and Rabeharisoa 2002) of collaborative work between clinicians and the Creative Works team. Of course, such qualification does not just happen because *all* clinicians become experts. The following quote belongs to an innovation

consultant who worked for IUs and reveals the way that medical expertise becomes contested in workshops. Talking about the employee involvement in workshops, the innovation consultant mentioned:

> *"…there is also something cultural in it, we want people to be equal so that nurses and head doctors to be…you know there can be a conflict there, so they have to go out of the clinical setting and come into a different space where the rules are different, so to speak. So they can participate in a more equal setting."*
>
> Monica, innovation consultant

The above quote reveals two of the relations that shape the qualification of interdisciplinary work within workshops. The first concerns equality and conflicts and the second is about rules in a particular space. Interestingly, both relations concern the interactions between clinicians. In this way, workshops contribute to the transformation of *all* clinicians into experts and participants but they also allow the reconfiguration or relations in-between experts. An examination of the specific artifacts and activities that constitute such workshops would clarify how such qualification takes place in practice and how the aforementioned equality and rules are performed. Here, the overall point is that workshops constitute a particular premise for the relation of IU to healthcare settings. Such premise is not neutral, it allows IUs staff to gain insights into clinical work but it also reconfigures IUs staff.

4.2 Summaries of case analyses: Collaborative modes of safety work

Introduction

The case analyses allowed the explication of different assemblages in each of which patient safety was enmeshed in the daily work of healthcare professionals in hospitals or other settings. The first case analysis examined the processes through which scenarios of critical events were developed in healthcare simulation settings. The second case analysis examined the processes through which young patient hygiene was maintained during play and teaching activities at the mother-child healthcare facility. The third case analysis examined some processes through which medical devices and services were developed within healthcare settings.

Two interrelated findings became apparent during the analysis of the aforementioned processes and set the ground for understanding collaborative design processes in healthcare: 1) healthcare professionals collaborated with each other on a daily basis and through different modes of dealing with patient safety 2) such collaborative modes were changing along with the healthcare professionals' appropriation of artifacts that constituted their workplaces. By using these two observations as a common point of departure, the rest of this section offers a brief summary for each case analysis.

The aim that accompanies these summaries is to put the most important analytical findings into perspective and to lay the ground for the concluding chapter that follows right after.

Case Analysis 1

Drawing on the empirical data that were generated at the healthcare simulation center "SIM", the first case analysis focused on clinicians who worked as instructors of healthcare simulations. It followed the work of instructors (including medical students) during the design and use of scenarios of critical events that supported the training of their participants (clinicians under simulation training).

Throughout scenario design, instructors used a standardized form of script (the script form) for designing new scenarios. Along with the generation of new scenarios, the interaction of instructors with and through the script form involved them in problematization processes. While designing new scenarios, instructors were able to share with each other their experiences with critical events that took place in care delivery processes and to collectively negotiate the framing of the new ones. Thus, scenario design entailed a mode of collaborative work that had multiple outcomes for participating instructors: 1) they generated new scenarios which became parts of SIM's material infrastructure (new scenarios could be used again and again) 2) each instructor had a potential to learn how his/her colleagues thought and acted upon similar critical events in care delivery and how they dealt with emerging situations during the use of script forms in role plays.

During, after and in-between role-plays, instructors interacted with and through script forms for coordinating their activities and for aligning their actions with those of the participants. Examples of coordination and alignment between instructors as well as their use of life-savers and corridors, revealed that the development of scenarios continued during the use of script forms in role-plays. The collaboration between instructors – in contrast with scenario design workshops – became a contested matter. This continuous development or *design-in-use* of scenarios resulted in the further problematization of critical events. The new aspect of such problematization is that it involved the efforts of instructors to facilitate role-plays and the performance of participants upon the seemingly complete scenarios. The mediating and multiple role of the script form allowed instructors and participants to engage with critical events in additional ways to those they have been dealing with in care delivery settings and in scenario design processes.

Case Analysis 2

Drawing on empirical data that were generated at the mother-child healthcare facility (hereafter facility) the second case analysis focused on the involvement of non-clinicians in the hygiene of young patients during play and learning activities. Having as a theoretical backdrop the notion of orderings, it examined non-clinician involvement in the production of clean/unclean toys, "clean enough" copies of educational material and in the development and use of a particular artifact, a spreadsheet.

The sub-case concerning hygiene and play focused on the individual and collaborative work of pedagogues and ward cleaners and revealed some of the multiple and heterogeneous orderings that maintained young patient hygiene in playrooms. Central to the heterogeneous ordering was: 1) The daily work of non-clinicians toward identifying, separating and storing clean/unclean toys. 2) The practices of non-clinicians for engaging other actors (e.g. parents) in the cleaning/uncleaning of toys. 3) The artifacts that enabled/afforded a continuous production of clean and unclean toys (e.g. racks and boxes). Non-clinician appropriation of formal hygiene systems (e.g. red and green boxes) revealed that multiplicity and co-existence of heterogeneous orderings was required for the continuous production of clean/unclean toys. Central to such multiplicity was the introduction and use of new artifacts that, on the one hand, blurred the boundaries between clean and unclean toys and, on the other hand, contributed to the continuous production of clean/unclean toys. The coexistence of those orderings came along with the collaborative work between non-clinicians, while undergoing various transformations; with the most central being 1) the transformation of toys into hygiene related artifacts, 2) the transformation of young patients' parents into potentially messed up users of playrooms and hygiene systems, 3) the transformation of young patients into students and 4) the inclusion of safety work in non-clinical practices (e.g. mobilization of children to play). The collaborative work of non-clinicians might have taken place in the same locations but in different times. This hints to the minimum, yet important-for-safety *coordination between the users* of hygiene systems (in this case these are non-clinicians and parents).

The sub-case about the production of "clean enough" copies of educational material focused on the work of teachers and revealed some of the orderings that enabled teaching activities to take place in isolation rooms without raising hygiene-related concerns. Central to those orderings was teacher use of a variety of clinically-related and other artifacts for 1) producing copies of educational material and 2) for entering the isolation rooms without construing a heterogeneous threat (teacher copies of educational material) for young patients. Two transformations took place in such ordering: 1) Teachers engaged in disinfection activities for becoming users of isolation rooms and 2) the latter were transformed into temporary classrooms. The ordering which concerned the emergence and qualification of the production of "clean enough" copies foregrounded some additional aspects that span across teachers' collaborative work and young patient safety. The bottom up development of the process for producing "clean enough" educational material was a counter-intuitive example of safety work: 1) the central and powerful actor was not the hygiene department but the pair of teachers, 2) while the hygiene department took part in the qualification of such process, it was the coordination between teachers and their efforts to integrate such process into their work practices that enabled them to use facilities, such as isolation rooms 3) the collaboration between the facility's previous and current teachers allowed such process to continue existing.

The sub-case on the development of a spreadsheet showed how young patient hygiene became enmeshed with the organizing of teaching work within the hospital. The spreadsheet allowed teachers to organize their physical movement within the hospital, to negotiate their

teaching role with nurses as well as to maintain awareness about and anticipate situations in which their teaching activities entailed safety work (e.g. the case of cystic fibrosis). Such example illustrates the finding that the interaction between clinicians and non-clinicians might lead to some forms of collaboration. These entail the involvement of clinicians in particular aspects of patient treatment (e.g. duration of patent stay at the hospital).
The overall point of the case analysis is that particular aspects of patient safety, such as the maintenance of young patient hygiene, became reconfigured through the daily work of non-clinicians and the appropriation of artifacts. The latter did not just enable pedagogues to mobilize children and teachers to teach students in hospital but also 1) rendered hygiene as a concern for pedagogues, teachers and other non-clinicians – who did not partake in the medical treatment of patients 2) configured a sociomaterial context where clinical and non-clinical safety work co-existed, even temporarily.

Case Analysis 3
Drawing on empirical data that were generated at a so-called Innovation Unit (IU) the third case analysis focused on the mutual engagement of clinicians and designers. It followed the collaboration between designers and clinicians at the early stages of development of devices and services that aimed to contribute to the safer delivery of care to patients.
Taking the establishment of an IU within the premises of a university hospital as a point of departure, the case examined: 1) the involvement of designers and clinicians in a mutual framing of safety work within healthcare settings and 2) some of the consequences that such framing has for the work of clinicians.
The approach of IU designers to the concept of innovation as a matter of public-private partnership revealed the transformation of patient safety from a concern that accompanied clinician work into a concern in the manufacturing of medical devices. The positioning of IU designers in between clinical work and the development of new devices made patient safety a contested matter which entailed ambiguous costs for the clinicians – and perhaps the patients, but not for the other actors (IU designers and manufactures).
The approach of the designers to clinical work as a context where challenges could be identified and problem could be solved also resulted into some transformation of clinical approaches to safety. Clinicians' challenges and ideas were approached as potential projects. Throughout such transformation, the focus was on the initiation and carrying of projects and much less on the methods and devices that allowed clinicians to become accountable for those projects.
The brief consideration of the method of workshops revealed two new ways that enabled clinicians to relate with patient safety during their work: 1) Clinicians participated as experts in the collaborative development of devices that could potentially contribute to safer care delivery. However, the involvement of such expertise came together with new ambiguous accountabilities which regarded the use of new devices and services 2) The participation of clinicians as experts required and/or enabled them to reconsider some of their relations with their colleagues. However, the consequences that such re-consideration may have had during care delivery are not clear. While this case analysis was the least developed, it revealed how patient safety serves as a backdrop for a mode of interdisciplinary and collaborative work that is not only mediated by artifacts but also by concepts and methods.

The next chapter, which is the concluding discussion of the thesis, departs from the findings that were highlighted in the above summaries for proposing two important aspects for understanding the emergence of collaborative design processes in healthcare. The first concerns the role of materiality in the continuous development of artifacts and the second concerns the spatio-temporal premises in which such continuous development takes place.

5. Concluding Discussion

Introduction and structure

This is the last chapter of the thesis and its main purpose is to put the findings of the case analyses into perspective. More particularly, the three sections of this chapter draw on some of the findings of the case analyses for the purpose of offering insights into the emergence of collaborative design practices in healthcare. Here it is worth reminding that the aim of the thesis is to make a practice-oriented contribution (see also Chapters 1 and 3). Schematically, this could be relevant for: 1) design professionals who focus on healthcare and have an interest about the role of use practices in the early stages of design and for 2) healthcare professionals (be they clinicians or non-clinicians) that have an interest in approaching their own work practices in light of collaborative design processes. The overall intention *is not* to offer a concrete tool that could be applied for designing potentially improved devices and services in healthcare[41]. Instead, the intention is to describe some elements of a *generative framework* (Suchman 2000) that the aforementioned professionals can draw on for: a) identifying the objects of design that they have a stake and 2) the consequences that such objects of design have upon their work. In a broader sense, these elements shall also help those professionals to reflect upon their position in light of *unfolding* objects of design.

As it became clear throughout the three case analyses and their summaries, healthcare professionals dealt with particular aspects of patient safety (e.g. critical events, hygiene) by partaking in various assemblages. Assemblages entailed collaborative work but also processes through which materially-mediated practices were formed. On particular occasions, the artifacts that constituted such practices problematized collaborative work rather than acting as intermediaries without agency (Callon 1991). Material and other artifacts allowed healthcare professionals to work in various collaborative modes and develop particular temporary spaces in which such work would take place. Thus, assemblages could be understood as entities that entail and enact *multiple locations of production and use* (Suchman 2002). The case analyses revealed some of the trade-offs that accompanied the use of artifacts during daily work of healthcare professionals as well as the establishment of routines around use practices of healthcare professionals. The appropriation of artifacts and their examination against a routine context that slowly changes has often concerned professionals who work at the early stages of design, (e.g. user studies), and researchers that have studied design-use relations (e.g. Aanestad 2003, Ehn 2008).

Taking these trade-offs as empirically-informed departure points, the following discussion draws on and maintains attention to the *mediating role of artifacts in the collaborative work of healthcare professionals*. An account of such mediation is important for understanding one particular way that collaborative design processes emerge in healthcare. This concerns the configuration and reconfiguration of sociomaterial contexts where the boundaries between safety work and use practices are contested and enacted rather than clear-cut.

Section 5.1 provides an overview of the ways that object-oriented notions have supported the approach of the thesis to non-human agency. Some empirical examples are discussed with attention given to heterogeneous knowledge practices that emerge in use contexts and their potential to inform the early stages of formal design processes.

[41] Some state-of-the art literature that reports some of these tools has been briefly mentioned in Chapter 1.

In section 5.2 the three elements of the aforementioned generative framework are presented. The first concerns a practical approach to objects as potential projects. The second concerns the role that materiality plays in the creative processes that accompany the daily work of healthcare professionals. The third concerns the identification and participation of designers in temporary spaces where continuous design can be empirically studied. The section rounds off by providing a summary of those elements and by focusing on the insights that these elements offer into the emergence of collaborative design processes in healthcare settings. Section 5.3 offers some reflections on 1) some methodological implications for approaching healthcare practices and how these can be related to collaborative design processes 2) the approach of this project to the general theme of *design for patient safety* (see also Chapter 1, Section 1.2).
Section 5.4 briefly outlines some potential academic areas that may support further the explication of emerging design processes in healthcare and the development of an object-oriented analytical framework.

5.1 Addressing non-human agency in design processes and use practices

Already, various researchers have developed notions for addressing the role of artifacts in the collaborative work of different professional communities, including designers (see also Chapter 2, Section 2.2). On the one hand, the notion of boundary objects (Star and Griesemer 1989) has enabled the thesis to study and analyze the collaborative efforts of healthcare professionals towards the elimination of risk (e.g. scenario design and role-plays of critical events). On the other hand – and this is more important in the thesis' approach to healthcare – a focus on the appropriation and circulation of artifacts in and across settings (Latour 1999) involved additional understandings of objects, such as epistemic (Knorr Cetina 2001, Ewenstein and Whyte 2009) and intermediary objects (Boujut and Blanco 2003, Vinck and Jeanette 1995) and conscription devices (Henderson 1999). The vocabulary upon which such notions were developed allowed the thesis to provide insights into:
1) The constitution of particular safety work practices in tandem with the emergence of broader modes of collaborative work (e.g. collaboration between pedagogues and ward-cleaners)[42].
2) The constitution of individual and collective trial and error in daily work (Clement 1993) and its support to healthcare professionals' approach to issues of uncertainty and risk (e.g. production of "clean enough" copies),
3) How the interaction of healthcare professionals with material artifacts (e.g. napkins) allowed the crossing and negotiation of sociomaterial boundaries that stood between seemingly distinct disciplines.
The materially-mediated interplay between the appropriation and circulation of objects as well as the emergence of work practices in *particular* healthcare settings has allowed the thesis to exemplify some processes during which patient safety was configured and reconfigured temporarily and locally.
Two of the aforementioned notions have been used more often in literature for explaining the effects that materiality has for collaborative design processes. These are the notions of epistemic and intermediary objects.
Ewenstein and Whyte (2009), for example, have studied the role of two and three-dimensional sketches (on paper) in the collaborative work of designers. In doing so, the authors have addressed sketches as *epistemic objects* that require from designers to define what these are about (and what they are not) through *a dialogical way; embodying a lack, raising a question,*

[42] In some cases such modes could lead to the identification of communities of practice (Wenger 1998).

begging an answer, unfolding, developing a lack elsewhere and raising new questions (p.27). Boujut and Blanco 2003 have studied the role of Computer Aided Design (CAD) models in the collaborative work between different engineers, including designers working toward the design of a product. The approach of the authors to CAD models as *intermediary objects* showed the transformative and mediating role of their material properties in the local conventions that designers made with each other as the design process moved forward.

Some analytical parts of the thesis (e.g. Case analysis 1, Sections 1 and 2) demonstrated that such notions may also support the analysis of materially-mediated knowledge practices that take place during the *use* of seemingly stable and complete artifacts. For example, script-forms were not just intermediaries in the design of new scenarios for simulation but they also allowed instructors to elicit knowledge about critical events during role-plays *as well as* in other, less formal, spaces (e.g. corridors). In doing so, the script-forms were transformed from artifacts into objects that had a multiple nature.

With reference to case analysis 2, red and green boxes were not just intermediaries between the hygiene department and the clean/unclean status of toys. While being appropriated in playrooms, these boxes problematized the use and professional practices of pedagogues and ward cleaners. In fact, such problematization required from those non-clinicians to forge new relations with humans and non-humans. Throughout such process their use practices produced local knowledge concerning the safety of young patients. There the boundaries between use and professional practices become unclear. In other words, the agential role of artifacts allowed non-clinicians to maintain young patient hygiene within playrooms.

With reference to case analysis 3, the employment of workshops by the designers who worked for Innovation Units was not just an intermediary that was used for making clinicians to participate in the formal design of new devices. It also transformed the ways that designers and clinicians approached patient safety within healthcare settings.

Within environments which afforded limited sets of interactions (e.g. scenario design workshops and working hours in playrooms), artifacts such as script-forms, copies of educational material, racks and others allowed healthcare professionals to accomplish their work by providing limited means for reflection upon such work. In other words, the use of artifacts as boundary objects took place in stabilized environments of interaction. The example of the scenario design workshop shows such issue more clearly. In such environment new knowledge about critical events came mostly through discussions that took place during the filling up of the categories of a particular artifact, the scrip-form.

However, *the formation* of boundary objects required from healthcare professionals to deal with those artifacts as intermediary and epistemic objects. For example, the development of an additional system (or ordering) that would allow toys to *become* clean/unclean continuously (and not only during working hours) problematized the relation of pedagogues with the existing system of red and green boxes. Instead of acting as boundary objects, the red and green boxes raised questions for pedagogues. These questions regarded the use, the potential misuse and the non-use of red and green boxes. To provide a practical answer to these questions pedagogues introduced new artifacts, such as napkins, ought to act as *intermediaries* between the parents and the system of the red and green boxes. However, napkins became *intermediary objects* for they required additional actions, such as the writing and hanging signs on the playrooms' walls. The above show some of the labors through which artifacts-as-boundary-objects become enacted in a way that allowed hygiene to fall into the background, instead of becoming a safety concern. However, these labors configure and reconfigure the set of relations upon which hygiene is

understood locally. In other words, the multiple nature(s) of artifacts allows them to actively participate in generation of materially mediated knowledge(s).
The maintenance of the criticality of a simulated critical event required instructors 1) to create a sense of uncertainty for their participants by staging scenarios as epistemic objects that raise questions 2) to enter into uncertain relations with their colleagues through seemingly complete script-forms. The second requirement did not just allow instructors to facilitate scenarios but it also problematized knowledge was generated in stabilized environments (e.g. scenario design workshops). These examples show that the daily work of healthcare professionals is not just about accomplishing a set of pre-determined actions where safety just happens to be integrated. Instead, it is about their participation in the problematization and reconfiguration of the boundaries that allow safety work to become a simultaneously shared and individual matter.
The above examples hint that the value of notions, such as intermediary and epistemic objects, *is not only* an analytical one that concerns a purely academic approach to non-human agency. Instead, they allow the generation of insights about the effects or consequences that artifacts-in-use may have. The empirical approach to patient safety practices has been helpful in the foregrounding of such effects because healthcare professionals often acknowledge quite explicitly the sociotechnical complexities that accompany their work. It is enough to remember one of the elementary school teachers comment about the cell the described blood infusion within the spreadsheet: "Blood infusion is a time in space". As mentioned earlier, empirical insights into such effects can contribute to the awareness of designers concerning the scope of the objects of design that they are involved. The practical challenge that arises for designers concerns the heterogeneous knowledge practices that emerge in use contexts and the ways that these may inform the early stages of the formal design processes, where there are greater opportunities for improvement and creativity (Koen et al. 2001) and for eliminating uncertainties that regard the scope of use practices. How to transform a rather general awareness about non-human agency into anticipation?
Below, three elements are presented that shall act as *sensitizing devices* and allow designers and other practitioners to reconsider the vantage point from which they partake in the design of objects which have their own agency, are incomplete and continue to be designed during their use. The attempt of transforming awareness into anticipation is a move of problematizing the position of designers (and those who might be in such position) and their "vision from somewhere". According to Suchman (2002) such vision is *is based in an embodied, and therefore, partial perspective that makes them [designers] accountable for it* (p.142).

5.2 Three elements of a generative framework

From objects to projects and processes
One empirically informed observation is that most of the objects that mediated the safety work of healthcare professionals fell outside intended or expected actions. For example, the scripts were used slightly differently each time and the red-green boxes were used in combination with other artifacts and not alone, as the hygiene department expected[43]. This brings into attention the processual qualities that accompany objects. As Haraway (1991) had put it:

[43] This, of course could have been also called de-scription (Akrich 1992). However, the implication of dealing with unexpected use with support from such notion is that it may easily lead to the consideration of healthcare professionals as "users". Then, their potentially multiple nature would be discussed with difficulty.

> *...objects are boundary projects. But boundaries shift from within; boundaries are very tricky. What boundaries provisionally contain remains generative, productive of meanings and bodies.*
>
> (Haraway 1991, p.201)

Then, one way for understanding how collaborative design processes unfold in healthcare settings is to avoid to draw a clear-cut distinction between locations of design and use but to look at when, how and whether boundaries between design and use are enacted. For example, instructors would never be able to design new and meaningful scenarios for their participants without having a common reference in clinically-based knowledge about critical events *and* the freedom to intervene when seemingly complete script-forms were appropriated in role-plays. It was the involvement of clinicians in healthcare simulation *as instructors* that allowed them to approach the objects or concerns of their daily work (e.g. critical events) as design projects. In this way, healthcare simulation allowed clinicians to train their colleagues, without putting patients in danger. However, there were site-specific objects/projects (e.g. scenarios) that allowed clinicians to become instructors and participants and, from such vantage points, to re-consider their own approaches to safety and care delivery.

Thus, sites of design are different from the places that seemingly complete artifacts are used. These differ only *to the extent and in the ways that boundaries between them are variously reiterated, reconfigured or erased* (Suchman 2007, p.205).

An appreciation of the capacities of artifacts to perform boundary work is central for approaching them as *objects of design* that unfold in daily work at healthcare settings. In other words, designers in healthcare should remain positively suspicious about what exactly is the daily work of those who will be/ are using their artifacts. This should be done without drawing a-priori boundaries that concern the scope of use practices. One way to remain positively suspicious is to approach artifacts as points of departure that potentially offer empirical insights into the *various work worlds* that their users belong and partake into, during their continuous reconfiguration.

Materiality and tinkering

The above discussed transformation of objects into projects was also accompanied with a change in the their material properties of artifacts that mediated the safety work of healthcare professionals. For example, the hygiene system was initially comprised by a set of two boxes that were mounted at the wall of each playroom. However, the use of the boxes according to the hygiene department's intention of treating clean/unclean toys as separate, led pedagogues *to introduce* additional artifacts, such as signs, napkins and racks for dealing with such clear-cut approach to hygiene and with the demands of their professional practices (e.g. mobilization of children through play). The introduction of those artifacts in locations that belonged to healthcare settings, the establishment of relations around and with them and, their integration into local safety work, point to the experimental and creative processes that healthcare professionals became involved in. Given that the relations between non-clinicians, the hygiene department and parents were new and, to some degree, ambiguous, they could be also thought of as a collective process of tinkering. According to Badham and Ehn (2000):

> *There is inevitably a degree of tinkering or bricoleur activity in tailoring universal principles or generic methods to local circumstances.*
>
> (Badham and Ehn 2000, p.78)

The ideas of tinkering and tailoring are important for appreciating the role of healthcare professionals in collaborative design processes and the extension of those into locations of use. One way to think about those ideas is to approach healthcare professionals as *workplace innovators* who accomplish safety work while they also develop capacities for responding to the variability (Zuiderent Jerak 2015) in which their safety work is enmeshed. Perhaps, tinkering and bricolage are some of the practical ways that healthcare professionals deal with uncertainty and risk.[44]

According to Badham and Ehn (2000) three aspects are important for workplace innovators: 1) they need to become aware of the configurations, translations and tailoring in which they partake, 2) they need to understand the complex nature of collective design and one way to do so is to see themselves as mediators that intervene in the contexts of use and 3) they need to anticipate the varying groups that are involved or affected by innovation (or design) that takes place in workplaces. However, these aspects *should not* concern the workplace innovators/ healthcare professionals but they should sensitize designers in healthcare to approach healthcare professionals as potential collaborators. In this sense, healthcare professionals should be treated as being already aware of (and accountable for) the configurations, translations and tailoring that they participate in, their mediating role in use-contexts and the ways that they involve new groups in such contexts. For example, the knowledge of non-clinicians about hygiene in playrooms may not just inform a potential update of the red-green box system but it may 1) offer insights into the broader, yet practical consequences that such update will have for parents, children, ward cleaners and all other groups 2) may offer insights into how accountability is distributed through use practices and heterogeneous use contexts. But such way of appreciating the relations of healthcare professionals with collaborative design requires from designers to re-consider their stake and role in design processes. If we accept that use practices contribute to the transformation of healthcare professionals into temporary designers, innovators or bricoleurs then the scope of design practices in healthcare requires reconsideration and reflection upon professional-related boundaries.

Temporary Spaces and Metamorphing

Throughout all case analyses, it became clear that collaboration between healthcare professionals took place in spaces that were temporarily constituted. Instructors collaborated during lunch breaks and under door frames, pedagogues and ward cleaners collaborated through a rack system that allowed them to work in different time frames (see Balatsas-Lekkas and Mesman, drafted), clinicians collaborated with designers in user-centered workshops and so on. A common theme that accompanies such spaces is the continuous development of (incomplete) objects of design. Door frames provided a less noisy space for instructors under which they continued to develop a seemingly complete scenario of critical events. Racks allowed pedagogues and ward cleaners to focus on their profession-oriented work while allowing them to transform toys into clean/unclean artifacts. User centered workshops allowed designers to engage clinicians for the development of

[44] Mesman and collaborators (e.g. Iedema et al. 2013) have been investigating healthcare professionals' creativity in other but similar terms. However, their approach has focused on clinicians and on processes that are much closer to the direct interactions between clinicians and patients.

potentially safer devices while the latter reconsidered their in-between relations. The above examples provide some insights into the active role of healthcare professionals in the configuration of such temporary spaces. The notion of *metamorphing,* which comes from a group of Scandinavian design researchers, is a helpful resource for thinking of the configuration of those spaces in light of the continuous design that took place in them. According to Binder et al. (2011b):

> *What emerges in design…is more an issue of successive giving form to the object of design. During this process, more is at stake than just the convergence of references. In many of our observations, we observed a reversed process of 'disordering'. Metamorphing is often outside of intentional acts. The interstice as such is the event; there is no goal, or the goal is of a second order to the experience of the in-between.*
>
> (Binder et al. 2011b, p.84)

The above quote shall be taken as an inspiration for thinking about how temporary spaces contribute to the metamorphing of objects of design that unfold continuously. The idea of disordering should not be taken as a negative one that hints to errors and risk taking. Instead, the notion that allows one (e.g. a designer) to search for the sociomaterial contexts in which objects of design become transformed. What is to be found is how objects of design are successively formed and how they transform those actors who take part in their formation.

For example, in-between two role-plays instructors were not just facilitators on lunch break. They had to actually draw on their negotiating skills, their cultural understandings of inter-professional relations and their clinical knowledge. The same counts for those entities which concerned instructors during breaks: Under the door fame, some participants in role-plays such as an old surgeon became acknowledged as annoying but also as potentially more experienced in critical events than instructors. The script-form did not just contain information about a finished (or a forthcoming) role-play. Instead, the doorframe contributed to the transformation of the script-form into an ordering device. By engaging with it instructors could: 1) reflect on their experience about the finished role-play, 2) organize their strategy about the forthcoming role-play by accounting for the annoying participant's knowledge about critical events and the capacity of all their participants to act within role-plays.

Thus, temporary spaces hold transformative capacities and intervene in the course of pre-defined events (e.g. from scenario design to role-plays) but also offer insights into the multiplicity of the entities[45] that partake in their configurations.

Recently, Clausen and Gunn (2015) have approached temporary spaces as a framework for analyzing how intermediary entities were staged in a series of participatory workshops. In doing so, they argued that temporary spaces sensitized their analysis of:

> *the staged intervention through distributed, shifting and temporary locales for mediation across institutionalised boundaries such as between diverse organisations, knowledge practices or between development and use.*
>
> (Clausen and Gunn 2015, p. 76)

Examples such as the aforementioned and others presented within the thesis (e.g. preparation of "clean enough" copies of educational material) hint that the notion of temporary spaces is many

[45] These entities can be human actors, concepts but also representations of actors.

more things than just suitable for describing actions toward the explicit formation of such spaces (e.g. staging). In empirical studies of use contexts and practices, temporary spaces can become a sensitizing device that allows the identification of temporalities in which the course of pre-defined events and the entities in them may become transformed in ways that were neither predicted by designers nor by those actively partaking in use practices. However, it should be stressed that those who are in position of identifying temporary spaces partake in a move of framing (Callon 1999) and therefore have a stake in them.

A more inclusive metaphor, which addresses such additional stakes and can be used in tandem with that of temporary space, is that of *design labs*. Binder at al. (2011a) describe as design labs a series of activities toward the collaborative development of devices and services that are kept together by design workshops. Central to Binder and colleagues' approach to design labs is that designers have multiple and potentially different agendas from those that participate in them. However, more important are two additional characterizations of design labs: 1) as learning spaces and as 2) being parts of a recursive process that allows for re-adjustments. Binder and colleagues have been preoccupied (like Clausen and Gunn, 2015) in describing what takes place in a particular form of design lab, the design workshop. A more explorative approach would be to address temporary spaces as design labs and seek to understand the constitution of use practices in them as well as the occasions where a designer *becomes a participant* (instead of being simply observant or a stager). This way of thinking about temporary spaces brings attention to:

1) The involvement of the designer into the processes through which other actors learn about each other and about their own work. Such involvement points to emerging materially mediated practices of all actors partaking in such processes.

2) The involvement of a designer into a recursive process that allows for re-adjustments, which are situation-specific and do not necessarily indicate a pattern. The pattern is the recursive process itself and not the readjustments that take place in it.

Therefore temporary spaces should not only be approached as being relevant for data generation but as spaces where the designer can identify his/her stake in them. What needs to be discovered is what exactly is such stake. In other words, it is *the role of designers as participants* in unfolding objects of design (during the use of artifacts) that allow them to re-adjust them (e.g. the development of a new device).

Summary of the three elements

The above elements, which had a basis on the analysis of assemblages of patient safety, offered insights on how collaborative design processes emerge in healthcare settings. Below follows a short summary of those insights.

An approach to the objects that are used by and concern healthcare professionals as potentially unfolding projects brings into attention the contingencies and particularities under which the design of artifacts continues into enacted contexts of use. Parts of the case analyses revealed that artifacts-in-use related healthcare professionals with particular aspects of safety (e.g. critical events) through modes of collaborative work and series of materially mediated actions that were, to some extent, uncertain. A conceptualization of objects as projects 1) allows designers in healthcare to remain reflexive about what they have identified as use contexts and 2) contributes to an alternative practical approach of use practices where the notion/idea of users should encompass their multiplicity rather than their relations to a particular artifact.

A focus on the relations that healthcare professionals enter with the material properties of the artifacts that they use brings into attention the creative processes through which collaborative safety work is accomplished on a day-to-day basis (as opposed to large scale safety initiatives). The central role of healthcare professionals (be they clinicians or non-clinicians) in such processes could be appreciated as relevant to design, if designers were to approach the former as workplace innovators who are already aware of (and accountable for) the configurations, translations and tailoring in which they participate and take place in use contexts. Such approach shall offer insights into 1) the consequences that come along with design processes that emerge in such heterogeneous use contexts and 2) the ways in which accountability is distributed through use practices. Such insights come at a particular cost for designers and might be construed as a "silent" problematization of professional design practices that takes place in use practices and contexts.

An attention to collaboration between healthcare professionals in temporary spaces offers insights about particular moments where objects of continuous design become meta-morphed. These spaces enact boundaries between human actors who interact within them, transform the entities that partake in their configuration and intervene in the course of pre-defined events. One way to deal with temporary spaces is to consider them as sets of activities that could be staged (e.g. facilitated workshops). Another way, which contributes to empirical research of use practices, is to consider temporary spaces as sensitizing devices that allow the identification and in-situ study of temporalities where design-in-use takes place. This way of approaching temporary spaces can allow designers to 1) remain reflexive while generating data from temporary spaces and not considering that one incident in one space is indicative of a use practice, 2) account for their stake in them since they become participants in (development of) materially mediated knowledge practices and, most importantly, 3) become aware of the learning processes that they do not just become witnesses of but also participants.

5.3 Reflections

Methodological implications in approaching design for patient safety

The study of patient safety practices and the explication of how such study would support an understanding of how collaborative design processes emerge in healthcare required several boundary crossings. These were mostly methodological and below I present some of them.

Since the early stages of the project I partially abandoned the idea of exploring what professional designers (aim to) do for improving patient safety and I focused on what may healthcare professionals offer to design. I attempted to do so by also accounting for the effects that my project had for those who became involved in it. One consequence was that design practices became accessible through the study of patient safety practices under the assumption that these were potentially design-in-use practices as well. I had to maintain a balance between my own thoughts and experience of design and design practices and become open to discovering design through the actions of my informants. However, the Danish healthcare system was new to me, since it was my first site for conducting an ethnographic study. This brought me to a position where my attempts to articulate in front of informants what my project was about and what its expected contribution was, had puzzling effects for the informants. The idea of *discovering* what is design within healthcare did convince some informants (and other implicated actors in the project). Making other interested about my project while also attempting to access the field

appeared as challenge. The following quote from Suchman reflects, to some extent, such early methodological challenges:

> *Boundary crossings are about encountering difference and entering onto territory with which one is unfamiliar and, to some significant extent therefore, unqualified to act.*
>
> (Suchman 2002, p. 94)

While my objective was to contribute to the explication of collaborative design processes in healthcare I had to make, to some extent, such project interesting for those who had an initial interest in it. I distinguish two stages in how this was done.1) While the early stages of the project were about encountering and being confronted by differences, 2) the later ones were mostly about becoming familiar with healthcare. In other words, the later stages were about crafting a particular territory with the support of various means. These means entailed an orientation towards qualitative research on patient safety practices, the collaboration with some key actors from such field, the identification and attendance to relevant conferences and events and so on. The remaining text will only focus one some methodological challenges.

Particular sites of ethnographic inquiry have informed my study of patient safety practices and their analysis as assemblages. Within the case organizations that informed the case analyses, I approached physical spaces, material and digital artifacts and, temporalities as potential sites for studying the formation of patient safety assemblages. Such way of employing ethnography, points to two aspects: 1) Its multi-sited-ness and 2) the inversion of artifacts into ethnographic sites.

1) Approaching the ethnographic investigation of healthcare settings as multi-sited has allowed me to remain receptive about where interesting things are going on (Hine 2007, p.661), as well as to craft of my own research object by specifically relating it to the particular argument of this thesis. However, it also brought the challenges of defining what is a field site, and most importantly, how to communicate to others what took place in it.

2) The inversion of objects into ethnographic sites has been informed by Bowker and Star's (1999) call for *infrastructural inversion*, in order to study seemingly unproblematic infrastructures and "boring things" (Star 2002). Additional inspiration was the call of Marcus (1995, p.105 - 110) for following persons, objects, conflicts, and metaphors, as well as connections, associations and relationships across different sites (see also Chapter 3, Section 3.2). Since the early stages of the PhD project the notion of inversion has helped me to depart my ethnographic inquiry in relatively unknown (to me) settings while attempting to remain reflexive towards alternative ways of working (Neyland and Simakova 2009). A conscious attempt to invert artifacts that were used by healthcare professionals into sites for fieldwork may also be understood through the engagement of Latour's notion of *reversible black-boxing* (1999). This allowed an understanding of the mechanisms that enabled objects to become (and remain) stabilized artifacts in particular temporalities and spatialities – in which safety and daily work co-emerged.

My strategy for following human and non-human actors in each case organization was to observe, and inquire with additional means (e.g. interviews and documents), how these were constituted in particular spaces and temporalities. After the end of the fieldwork I realized that the engagement of different sites had allowed me to appreciate the complexities in which patient safety is implicated. This is because I became aware about: a) The practical ways that my actors

dealt with complexity throughout their daily work, rather than defining patient safety a-priori as an extraordinary state of affairs. b) The enactment of multiple patient safet*ies* by different, yet interrelated, interdisciplinary work practices.

I had initially been challenged by the task of accessing case organizations and by attempting to remain open as to what is a (different) site. At later stages of the PhD project my reference to such challenges (e.g. by reviewing old writings) allowed me to distinguish between my conceptions of what temporary and local meant to me, to other researchers of patient safety practices and to the informants of this study.

Throughout an ethnographically grounded process of conducting participant observations and interviews at workplaces, I focused my fieldwork on the iterative organizing of healthcare professionals' work. I did so by attending to sustained and explicit or new and implicit practices that I gathered as potentially relating to patient safety. A relatively simple tool that has allowed me to do that was to point at artifacts that my informants (or other actors) carried or used and seemed interesting to me and ask them: *What is this?* The responses that I got back were always interesting (in relation to my object of study) and surprisingly complicated. This created a sense that fieldwork was always incomplete and it took me some time to move forward.

Furthermore, my study of the local and practical organizing of work in healthcare was influenced by the circumstances that patient safety was becoming a concern for my informants. These entailed formal and informal work, routine, articulation, mobility and invisible work. In this way, I aimed to study how patient safety related to different - yet particular work practices in healthcare. As I have already mentioned in Chapter 3, my interest was in the ways that patient safety emerged as a temporary and spatial achievement and not as an issue of preventing errors. This approach has led to me to examine particular topics of patient safety and to exclude others. Hygiene at the mother child facility, for example, became an interesting topic for me because it the management of the facility had initially framed it as technical challenge. By drawing on STS sensitivities I deemed such framing as *seemingly* univocal and therefore interesting to study it further.

Making patient safety relevant for collaborative design

The overall research project offered a chance for studying design "from within" - that is, design in use-practices. This way falls into, what Suchman has called, the Scandinavian approach where the focus is on the appropriation of artifacts into contexts of use for the purpose of *informing design practices*. The appreciation of use practices and contexts within healthcare settings through the theoretical lens of Science and Technology Studies came with particular expenses.

One of them was a heightened attention to wordings such as safer care, usefulness, integration, maintenance, systems and others. These wordings were present in literature about *design for patient safety* (see literature cited in Chapter 1, Section 1.2) as well as in the daily work of my informants (e.g. see opening vignette in the article placed in appendix 2). During fieldwork and the later analysis of data I attempted to transform these wordings into *notions* which would deserve further analytical attention. An STS-informed way of transforming such wordings was to approach them as verbs: *delivering safer care, integrating, maintaining, systematizing* and so on.

Such transformation required 1) time, since it opened opportunities for understanding how the aforementioned verbs were performed in practice, 2) positioning in relation to existing literature and 3) a *cautious empathy* about informants and their efforts to perform the actions entailed in the aforementioned wordings. There is not just one type of general empathy that fits all informants (and literature). It would never be possible to empathize in the same way with the

efforts of professional designers who worked within an IU for designing better and safer devices and the efforts of elementary school teachers to develop a process for accessing isolation rooms or to develop a spreadsheet for navigating within the mother-child healthcare facility. The same counts for seemingly neighboring literatures that became actors during the course of this project. Here is an example: A positive approach to patient safety might depart from an empirical inquiry about "what works well" during pre-defined critical events and risky situations (e.g. Holnagel et. al. 2015) and to be followed by an assessment that is based on the identification of distinct factors. But another positive approach to patient safety might also depart from an empirical inquiry into what works well for *most of the time* and try to understand how exactly things work well and what are the strengths of those partaking in their working (e.g. Mesman 2011). These two approaches have a common departure point but a different appreciation towards what needs to be studied and appreciated. An attempt to equate them, in terms of their contribution to the unraveling of patient safety assemblages would be unfair. Within the first, it is circulated a fundamental assumption that belonged to older and more generic paradigms of safety: humans, despite their multiplicity, can be approached as distinct factors that affect and interact with healthcare systems. The second elicits new relations that may also be enmeshed, to some extend, with those older paradigms and it does so by making visible how these are performed in practice.
As far as it concerns this project's treatment of informants, empathy had to be crafted *throughout the course of the project* in two interrelated ways: 1) by drawing and/or "cutting" the sociomaterial assemblages that informants were implicated in (Suchman 2007) and 2) by becoming aware of the informants' capacity of normativity (including intentions) and the norming practices that they were implicated in and performing (Zuiderent-Jerak 2015). The attempt to apply such cautious empathy to the analysis has led the thesis to propose the above-presented elements of a generative framework. These shall sensitize designers to consider what actions might constitute design in use contexts. This brings into focus two last questions: If design continues into use practices then, is everyone a designer? If everyone is potentially a designer then what is the role of the professional designer? Suchman (2007) has suggested that distinctions between designers and users

> *…describe persons differently positioned, at different moments, and/or with different histories and future investments in projects of technology development.*
>
> (Suchman 2007, p. 278-279)

The above quote provides the grounds for an explorative approach to the first question and a partial answer to the second.
Design may continue into use but what does *not* make everyone a designer is the necessary work of framing and translating use-practices as relevant for design and designers. In other words it is the knowledge practice that has affinities with the synthesis of seemingly distinct and unrelated elements which makes the difference between designers and potential or "silent" designers. This project has been an attempt to make such synthesis despite the uncertainties and obscureness about what had to be synthesized. Moreover, the uncertainties that occurred could not be approached through bookshelf methodological solutions that provide a seemingly generic (and therefore particular), roadmap through a series of descriptive and prescriptive studies of pre-defined study objects (e.g. Blessing and Chackrabarti 2009). In other words this PhD project did not approach design as a process of problem solving but as a sociotechnical process where designers have a role to play among those of many other actors. In addition: What would the

contribution to the daily work of healthcare professionals be if they were to be told that they might be potential designers?
The above answer hints that design professionals have a role to play in use contexts and such role needs to be situated and discovered together with the objects of design that unfold in use contexts. In other words, designers have to able to identify and move in-between objects of design by accepting to become participant-designers. The development of reflexivity toward the identification of those objects of design that require a design-participant role might be a first step into reconsidering the role of designers in situations that everyone seems to be a potential designer.

5.4 Future lines of research

This project has provided some insights into patient safety practices and the ways that these become relevant to emerging collaborative design practices in healthcare. However, there is more research that can be done and it can be distinguished in two general directions. The first concerns the expansion of the practitioner-oriented framework that was described above and the second concerns the constitution of an analytical framework for explicating relations and boundaries between design and use practices.

1) Having patient safety practices as its backdrop, this project outlined three elements/sensitizing devices that inform design-oriented practitioners about how collaborative design processes take place within healthcare settings. While those elements have pointed to some directions where design-in-use becomes visible they were generated through a somewhat limited empirical research on patient safety practices. Hor et al. (2013) have shown that safety work does not only involve clinicians and non-clinicians but also patients and their families. Then, in the article about non-clinicians (appendix 2) there was also some small part dealing with the parents of young patients and their involvement into the latter's safety through the use of particular systems. Such actors become interesting for this framework since their ways of acting within healthcare settings has not yet been considered as potentially creative but as a matter of following/un-following well designated procedures. Another potential theme that could be addressed in the framework is the organizational and organizing work through which large patient safety initiatives are transformed into particular artifacts and procedures (such as the system with the green-red boxes in each playroom). These themes would allow a focus on those actors that seem to have some distance from or are less involved in the actual practices of care delivery (e.g. top management, safety and quality experts). They could also be seen as departure points for inquiring further/other use-practices. It is very likely that an exploration of these themes would generate more elements for the above-mentioned framework and it would also strengthen the empirical basis of the three existing ones that were described above.

2) Relations between design and use practices have been of particular interest in Scandinavia for quite some time (e.g. Greenbaum and Kyng 1991) and more recently have been informed by Science and Technology Studies (e.g. Aanestad 2003). Since then, and having an empirical backdrop, various analytical devices have been developed and helped the explication of such relations. The approach of domestication of technology (e.g. Sørensen 2006) has presented detailed studies of use-practices and has offered another rich vocabulary for describing them. Appropriation, objectification and conversion are some parts of it. Moreover, notions such as that of *infrastructuring* have become interesting for STS-informed researchers who have studied

collaborative design in the "wild" – that refers to the use contexts (e.g. Karasti and Syrjänen 2004). The thesis' employment of various object-oriented notions as an analytical vocabulary might be a useful analytical resource for considering the multiple and agential role of artifacts in collaborative design processes that span across and problematize the boundaries between design and use contexts. Each notion has helped the analysis in different, yet complementary ways to address the agential role of artifacts. The constitution of boundary objects brought attention to the development and reconfiguration of sociomaterial boundaries between humans and non-humans. A focus on the processes through which intermediary objects were constituted foregrounded how artifacts become transformed into objects of design within contexts of use. A treatment of artifacts as entities that generate questions for their users has brought attention to the gain and loss of agency. The notion of conscription devices has shed light into how artifacts enroll their users, be they designers or others, in unfolding objects of design by requiring from them to become participants.

A next step would be the development of a more coherent framework where each notion and its vocabulary would be explicitly applied for the analysis of empirical material Ultimately, such vocabulary would support the detailed analysis of the translations and displacement through which artifacts become agential entities or loose their capacity to act. This thesis has just provided some few indications of how this can be done. However, more translations or tailoring in-between those notions are needed. The theoretical arguments that have accompanied these notions entail various points about non-human agency. The further clarification of similarities and differences between them shall bring new insights about the ways that artifacts act in collaborative design processes.

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7. List of interviews

2013
Lene Laursen (Medico Industrie)
Peter Dieckmann (Copenhagen Academy for Medical Education and Simulation)
Birthe Oest Larsen (Nordsjællands Hospital)
Werner Hugo Sperschneider (Videncenter for Innovation of Forskning)
Demos Tzamaloukas (Copenhagen Municipality)
Inger Marie Ulriksen (Quality Unit, Nordsjællands Hospital)
Peter Dieckmann (Copenhagen Academy for Medical Education and Simulation)

2014
Peter Kyhl (Nyt Hospital Nordsjælland)
Bent Ottessen (Juliane Marie Center, Rigshospital)
Anne-Mette Helsøe (Copenhagen Academy for Medical Education and Simulation)
Rikke H.G. Malene (Copenhagen Academy for Medical Education and Simulation)
Jepsen Lasse Olsen (Copenhagen Academy for Medical Education and Simulation)
Kim Ekelund (Copenhagen Academy for Medical Education and Simulation)
Anne Marie Hellebek (Unit for Patient Safety, Region Hovestaden)
Christian Tvede (GameLab 4 Healtch, Odense Universitetshospital)
Anne Mette Bang Termansen (Juliane Marie Center, Rigshospital)
Sara Gry Striegler (Videncenter for Innovation of Forskning)
Pernille Mejer Højholt (Facilitate to Innovate, Region Nordjylland)
Jesper Jønsson and Sanne Daugaard (Ideklinikken, Region Nordjylland)

2015
Anni Juhl Jørgensen (Infection-Hygiene Unit, Nordjaselands hospital)
Charlotte Blix Rigshospital (Juliane Marie Center, Rigshospital)
Ida West Jacobsen (Juliane Marie Center, Rigshospital)
Laila Uhrskov Hansen (Juliane Marie Center, Rigshospital)
Vivi Marlene Noergaard (Juliane Marie Center, Rigshospital)
Kasper Sejerslev and Janus Blomfrø (Juliane Marie Center, Rigshospital)
Singe Milling (Juliane Marie Center, Rigshospital)
Susie Mathiesen (Infection-Hygiene Unit, Rigshospital)

Article appendix

Appendix 1.

Single authored article submitted to the special issue of "Insrastructuring and Collaborative Design in the Journal of Computer Supported Cooperative Work (CSCW).

Title:

Infrastructuring in healthcare simulation: A case of collaborative design "in the wild"

Author
Angelos Balatsas-Lekkas

Affiliation
PhD student

Address for correspondence
Technical University of Denmark
DTU Management Engineering
Diplomvej
Building 372
2800 Kgs. Lyngby
Email: able@dtu.dk
Mobile phone: +358442392002

Note: In this submitted version references are made to the "setting of primary care", which can be misleading. It is intended to mean the primary setting of care, as it is in the hospital.

Appendix 2.

Co-authored article. To be submitted (after the delivery of the dissertation) to the journal "BMJ Quality and Safety".

Title:

Toys and teachers in children's hygiene:
Examining non-clinicians' contribution to patient safety practices.

First Author
Angelos Balatsas-Lekkas

Affiliation
PhD student

Address for correspondence
Technical University of Denmark
DTU Management Engineering
Diplomvej
Building 372
2800 Kgs. Lyngby
Email: able@dtu.dk
Mobile phone: +358442392002

Second author
Jessica Mesman,

Affiliation
Associate professor

Address
Maastricht University
Faculty of Arts and Social Sciences
Minderbroedersberg 4-6
6211 LK Maastricht
Email: j.mesman@maastrichtuniversity.nl